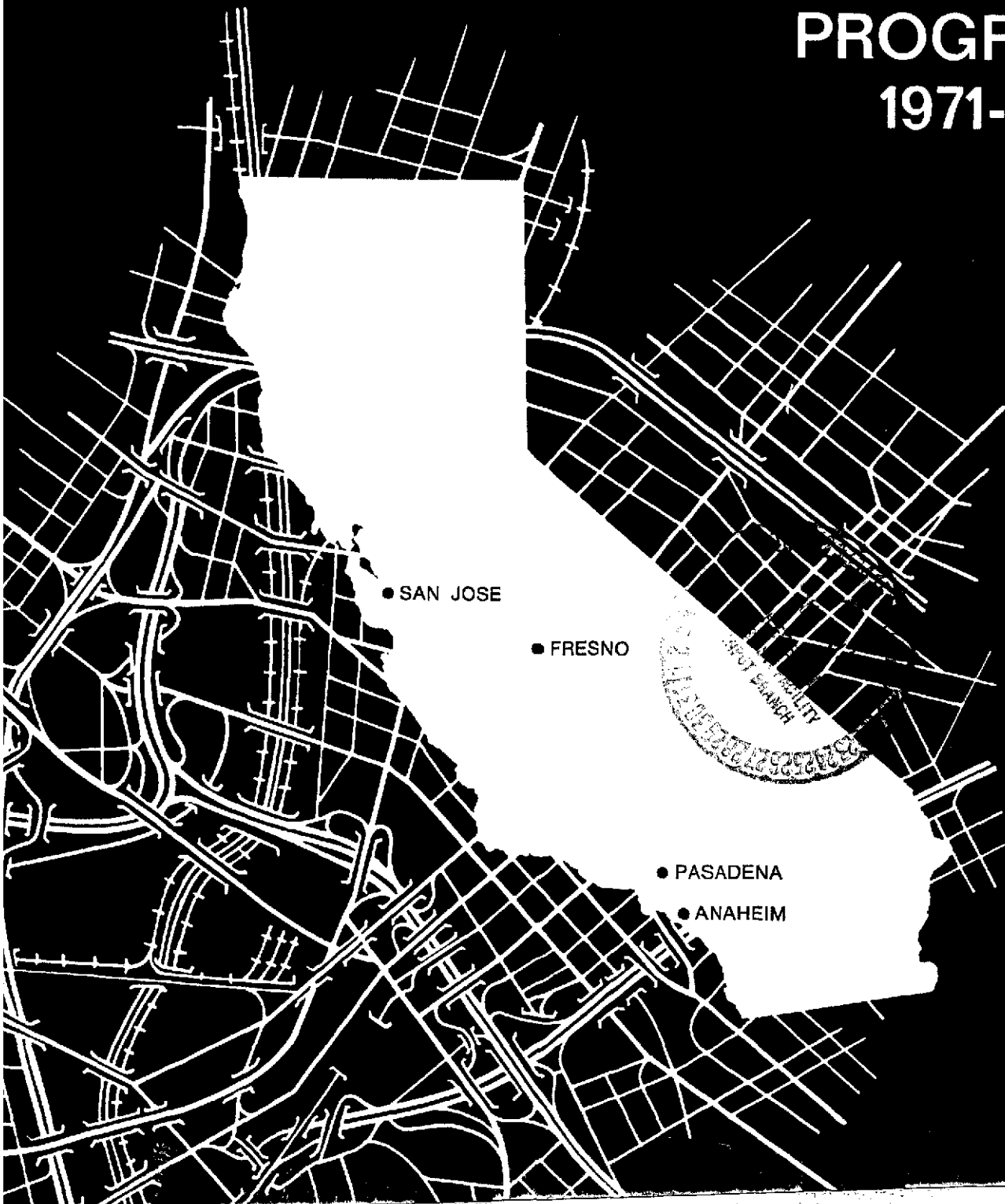
CALIFORNIA FOUR CITIES PROGRAM 1971-1973



CALIFORNIA FOUR CITIES PROGRAM 1971-1973

H. L. Macomber
James H. Wilson

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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ABSTRACT

A pilot project in aerospace-to-urban technology application, co-sponsored by the National Aeronautics and Space Administration and the National Science Foundation and managed by the Jet Propulsion Laboratory (JPL), was begun in 1971. Four Companies each assigned a senior engineering professional to serve as Science and Technology Advisor in one of four participating city governments. Technical support was provided by the Companies and JPL. The four Cities, Anaheim, Fresno, Pasadena, and San Jose, California, provided the working environment and general service support. Each City/Company team developed and carried out one or more technical or management pilot projects together with a number of less formalized technology efforts and studies. This document provides an account and evaluation of the initial two-year phase of the Program, which has been continued and extended.

The initial effort demonstrated the effectiveness of this mode of technology application and communication. The capability of Companies and Advisors to contribute needed new technique to urban management, and of Cities to use and institutionalize research and development product and methodology, was shown. Specific management methods, software systems, and to a lesser extent advanced hardware were introduced and used.

In the Cities, a more receptive environment for technology introduction was fostered, the value of the advanced research and development approach to problem definition and evaluation was demonstrated, and the communication and control techniques of systems management were institutionalized. In the Companies, new insights regarding local government as a system and advanced-technology user were developed, although the development of an aggregated market for hardware products was recognized as a distant and complex goal. The needs for access to broad technical support and advice, and an active coordination and intercommunication role, were demonstrated.

ACKNOWLEDGMENTS

This document is based in part on material prepared by various authors for diverse purposes. The Science and Technology Advisors to the four Cities contributed through their quarterly reports and other documents, with some interviews and conversations. They are William Armstrong, Northrop Services, Inc.; John Glascock, North American Rockwell; Michael Licciardello, Science Applications, Inc.; James Wakeman, formerly of TRW Systems Group; Forrest Warren, Aerojet Liquid Rocket Company; and Jerome Weiss, Lockheed Missiles and Space Company. Lloyd S. Blomeyer and George F. Ervin of JPL's Project Engineering Division, authors of the First Annual Report, are due a special debt of gratitude for contributions and criticism, as are M. E. Alper and G. E. Nichols Jr. of JPL's Civil Systems Program Office. Dr. Gilbert E. Brighouse made special contributions to the evaluation of the Program.

The City Managers, Keith Murdoch of Anaheim, Bruce Reiss and Les White (pro tem) of Fresno, John Phillips, Donald McIntyre, and Donald Pollard (acting) of Pasadena, and T. W. Fletcher, Ted Tedesco, and Franklin Krofler (acting) of San Jose, and members of their staffs and Departments made, over the two years of this Program, many collective and individual contributions to the progress, evaluation, and understanding of the Program. In like manner, managers and technical staff members of Aerojet Liquid Rocket Company and Space General, Lockheed Missiles and Space Company, Northrop's Electro-Mechanical Division, Science Applications, Inc., TRW Systems Group, and North American Rockwell Information Systems Company made many contributions to the Program and, through it, to this report.

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I. INTRODUCTION

One of the predominant dynamic characteristics of modern civilization is that in the course of natural progress, inequities between various sectors of societies tend to increase rather than to disappear. In no medium of value is this growing difference between the "rich" and "poor" so important to society as in the coin of knowledge, specifically the species of knowledge called techniques, skills, and the arts of management, organization, and operation of systems.

Our society has tried to ameliorate these technological inequities in various ways from time to time. Successful propagation of laboratory knowledge and industrial approaches into major portions of the American farm economy has been the century-long mission of the U. S. Department of Agriculture. Introduction of more modern techniques to village agriculture, public education, and other sectors in many developing nations, with a methodology stressing acceptance by the recipients, characterized the cultural and technical transfer operations of the foreign aid programs of the 1960's, especially the Peace Corps. But this mode of large-scale, relatively systematized, and broadly supported transfer and diffusion of technique requires a large and sustained effort, considerable social/management skill, and local receptivity. Therefore, it is not surprising that such programs are uncommon, notwithstanding the need for them.

One area of such need which remained relatively unnoticed until the past decade is urban management. With the rampant growth of cities, both vertical and horizontal, in recent decades, needs have outstripped local capabilities and resources, available techniques, and the traditional lines of political communication. During the period since the start of World War II, however, federally-sponsored research, originally related to military and later to space-exploration needs, had developed a large body of technique, knowledge, and hardware, and a research and development establishment of capabilities, potentially exceeding the immediate demand.

Naturally certain specific need areas, notably those in proximity to military operations, have benefited from technique and device transfer on a piecemeal basis. Urban law enforcement has seen the greatest technical advance in this period, with improvements including aviation support, communications, tactical training, and weaponry. Aspects of this area of transfer have proved controversial at the very least.

Other activities in the transfer of federally-sponsored research to civil application resulted from conscious efforts to broaden the application of new advanced technology, particularly on the part of the National Aeronautics and Space Administration (NASA). Significant if isolated improvements have resulted, for example, in airports and highways, and in various industrial work. But an urban analogue to the Peace Corps or the Agricultural Extension Service – that is, an operating transfer system between the sources of new technique, equipment, and knowledge and potential urban users – did not exist even in working prototype. The California Four Cities Program, sponsored jointly by NASA's Office of Technology Applications and the National Science Foundation's Office of Intergovernmental Science and Research Utilization (NSF OISRU), and managed by Caltech's Jet Propulsion Laboratory (JPL) was designed to respond to this need. This Report is an account and evaluation of the first two-year phase of that Program.

A. PROJECT CONCEPT

The Program, formally titled, "A Pilot Demonstration Project of Technology Application from the Aerospace Industry to City Management," was intended to explore and demonstrate new modes of linking a major source of federally-sponsored new technology with an important class of potential user, local government. Its operating form was to establish a direct and personal link between a local government – a Council/Manager form of city administration – and an aerospace firm, by assigning an experienced senior professional from the Company to the City Manager's staff. Four such City/Company teams were to be set up, with JPL coordinating and managing the Program, evaluating its results, and providing technical support in addition to that offered by participating Companies and Cities.

These operations were intended to provide several general and local benefits. First, the process of transfer between these two classes of activity could be studied and demonstrated in some detail and with a modest degree of generality arising from the multiple-case operation. As a corollary, successful accomplishment within the program might inspire or encourage similar activities elsewhere. Second, both institutional partners in each working team would learn beneficially from the experience: the Cities would be familiarized with a new spectrum of potentially useful technology, and the Companies with a new field for the application of their developed skills. In turn, it was hoped this experience would lead ultimately to ways of establishing a production-scale marketplace between these institutions. Third, specific beneficial transfers of technology would occur. Because of the small scale of the program, these would not likely amount to production-run

quantities of immediate advantage to participating industry, so that the benefit would be immediate to the city but probably only potential to the producer. Last, but most important for the viability of the continued transfer process, the program promised an improvement in human understanding, and a growth of sympathy, between team members, social and technical.

B. OBJECTIVES

The California Four Cities Program was designed to operate according to the general objectives chosen by NSF's Intergovernmental Science Program. These are listed in Table 1. Specific objectives of the Four Cities Program are given in Table 2. These objectives were stated in the Proposal, and reiterated periodically in reports of the Four Cities Program's activities.

Table 1. General objectives

1. To advance the understanding of public issues and problems having scientific and technological content at the State and local levels of government, and to assess needs and opportunities for more effective application of science and technology.
2. To demonstrate innovative science and technology planning and decision-making processes related to State, local, and regional problems.
3. To stimulate selected State and local governments' experimentation, on a pilot basis, with science and technology systems in the context of their own needs and resources.
4. To encourage adoption of new systems which show promise for enhancing State and local ability to incorporate science and technology into public programs.
5. To improve communication between persons and groups concerned with science and technology at the Federal, State, and local levels of government.

Table 2. Specific objectives

1. To determine the ability of industrial aerospace professionals to contribute directly in the environment of the cities at this level.
2. To determine the nature and amount of technical support required to implement a program to bring aerospace technology to local governments.
3. To expose city personnel to the "systems approach" and thereby enhance their performance through this educational process.
4. To expose aerospace personnel to the socio-political process in the cities to enhance their understanding of the cities' problems.
5. To assess the applicability of aerospace technology and expertise to problems of the cities.
6. To evaluate whether or not this type of arrangement is beneficial to the cities and to the aerospace industrial community.

C. PROJECT INITIATION AND SUBCONTRACT SUMMARY

The program was conceived and developed as a result of the mutual interest of the National Science Foundation's Office of Intergovernmental Science and Research Utilization and JPL's Space Technology Applications Office, which functioned under the support of NASA's Technology Applications Office, managed by Mr. R. D. Ginter. NSF's Director of Intergovernmental Science Programs, Dr. M. Frank Hersman, had urged the total-process approach to urban technology transfer in various media, notably through the President's Committee on Intergovernmental Science Relations (Ref. 1). The Laboratory, through Space Technology Applications Manager D. F. Spencer and Technology Transfer Administrator R. T. Diehl, was seeking new ways of supporting and implementing NASA's technology applications mission to promote dissemination and transfer of space technology to new users and uses.

Following constructive discussions and conferences, and an exploratory investigation of the local-government field in California, the Laboratory submitted to NASA and NSF, in February 1971, a proposal for the effort which was later named the Four Cities Program (Ref. 2). Subsequently, a NSF/NASA Interagency agreement (Ref. 3) was executed to establish funding support, and implementation of the effort was approved. A chronology of these and subsequent activities is given in Appendix A.

Initial contacts with potential City/Company team pairs had preceded submittal of the proposal, and letters expressing interest in participating had been received from a number of candidate institutions. Initial procurement contacts were made in late May and early June 1971 with the release of single-source Requests for Proposal.

Pending the conclusion of contract negotiations between the Laboratory and the four participating Companies, project operations were begun. An initiation meeting at JPL in June 1971 brought together representatives of the Cities, Companies, sponsoring and project-management agencies, and the four Company professionals who were to fill the key positions of Science and Technology Advisors to the City Managers participating in the program. Soon (but still in advance of contract conclusions) some Advisors began their City assignments. The structure of the Four Cities Program activity at this stage is shown in Fig. 1.

Contracts were executed with TRW Systems Group, Lockheed Missiles and Space Company (LMSC), and Aerojet's Space General Company in September. The fourth Company, North American Rockwell Information Systems Company (NARISCO) agreed with JPL to terminate contract negotiations early in October 1971. NARISCO further agreed to support the program without compensation in the interim, however, and maintained a professional as Anaheim's Advisor through the calendar year. Discussions were begun with the Northrop Corporation almost immediately, resulting in a contract signed in January 1972. The contracts with the Companies are listed in Table 3.

PROGRAM SPONSORS			
NSF/OISRU M. F. HERSMAN		NASA/TA R. D. GINTER	
PROJECT MANAGEMENT: JPL PRINCIPAL INVESTIGATORS: D. F. SPENCER/R. DIEHL TASK LEADER: J. C. PORTER JR.			
CITY	MANAGER	ADVISOR	COMPANY
ANAHEIM	K. MURDOCH	J. GLASCOCK	NARISCO
FRESNO	B. REISS	J. WAKEMAN	TRW SYSTEMS
PASADENA	J. PHILLIPS	F. WARREN	AEROJET
SAN JOSE	T. W. FLETCHER	J. WEISS	LMSC

Fig. 1. Four Cities Program configuration, 1971

Table 3. Four Cities Program contracts

JPL Contract No.	Contractor	Date of Execution
953254	TRW Systems Group	September 2, 1971
953251	Aerojet (Space General)	September 22, 1971
953252	LMSC	September 22, 1971
953367	Northrop Corp.	January 13, 1972
953553	Science Applications, Inc. (La Jolla Research & Business Assoc.)	September 7, 1972

As set forth in the Proposal and the Interagency Agreement, support for the Advisors' salaries, fringe benefits, and travel expenses was to be provided from NSF funds, and support of JPL activities from NASA. Material and service support of the Advisors' activities in the Cities was provided by the Cities, while the Companies' expenses for administration and the like, together with supervisory and technical support to the Advisors, were donated by the Companies. Thus, the program was in all respects a cooperative effort.

At the end of the first year of the two-year period, TRW Systems requested that its participation in the program not be continued. La Jolla Research and Business Associates, a subsidiary of Science Applications, Inc. (SAI) was selected competitively to carry on with the City of Fresno. The other three City/Company teams carried on unchanged, except for an internal reorganization of Aerojet-General which made that Company's Four Cities activity part of the Aerojet Liquid Rocket Company of Sacramento. The 1973 configuration of Four Cities activities is given in Fig. 2.

D. GENERAL RESULTS

This Program demonstrated the premise contained in its first objective, that aerospace-industry professionals can contribute to the improvement of city management in a direct

PROGRAM SPONSORS			
NSF/OISRU M. F. HERSMAN		NASA/TA R. D. GINTER	
PROJECT MANAGEMENT: JPL PRINCIPAL INVESTIGATOR: L. S. BLOMEYER[a] TASK LEADER: G. S. ERVIN			
CITY	MANAGER	ADVISOR	COMPANY
ANAHEIM	K. MURDOCH	W. ARMSTRONG	NORTHROP
FRESNO	B. REISS[b]	M. LICCIARDELLO	SAI/LJRBA
PASADENA	D. McINTYRE[c]	F. WARREN	AEROJET
SAN JOSE	T. TEDESCO	J. WEISS	LMSC

[a]REASSIGNED AUGUST 1973, SUCCEEDED BY H. L. MACOMBER

[b]RESIGNED AUGUST 1973, APPOINTED NSF PROGRAM MANAGER SEPTEMBER 1973; SUCCEEDED BY L. WHITE (PRO TEM), R. HANLEY (APPT SEPTEMBER 1973)

[c]APPOINTED MARCH 1973, ON RETIREMENT OF J. PHILLIPS

Fig. 2. Four Cities Program configuration, 1973

Industry/City technical interface role. It thoroughly explored some aspects of this interface.

The Four Cities Program was partly or fully responsible for the introduction to city-management consideration or use of a number of new devices and methods, including public-safety hardware, planning software, system management and integration approaches, and a variety of management-technique improvements. The Cities indicate considerable cost savings and operational improvements resulting from these changes, and generally attribute the greatest change — though its effects are difficult to measure explicitly — to the dramatization and propagation of the systems approach to problem definition and solution.

The most important result of the Four Cities Program was its demonstration in four cases of the effectiveness of its chosen mode of technology transfer from industry to urban management. This mode has essentially three aspects: institutional learning, the professional "change agent" acting at the interface, and inter-city coordination and reinforcement. The Program identified an institutional role for the furthering of regional coordination and reinforcement, filled in this instance by the Jet Propulsion Laboratory.

Finally the Program investigated and carried out some phases of the complex learning growth necessary to the successful transfer of high technology to local government applications. It demonstrated that the acquisition and internalization of the essential new methods and approaches is not a quick or easy undertaking, and that its healthy maintenance requires continued efforts. The Program has been extended in order to study the process further, particularly in the area of inter-city technical collaboration and the integration of cities with State and other governmental science and technology activities.

Three fundamental elements acted in the aerospace-to-urban-technology transfer process in the cities of this Program; a fourth integrated the four City operations into an organic whole. The City as technology user, the Company as technical resource, and the Advisor, as principal transfer agent, constitute each City team. The project management agency, JPL (which served as an additional technical resource) is the integrating element.

A. CITY CONDITIONS

The typical city of the Four Cities Program is middlesize (population 100,000-500,000, area 25-150 sq. mi), surrounded by a suburban region with smaller towns, undergoing change and growth. It has a Council/Manager form of government, and a moderate degree of contact with advanced technology, from industry, campus, or previous transfer projects.

Actually one of the four, San Jose, has grown beyond the half-million mark; another, Pasadena, has declined slightly in population over the past decade. The two northern cities, Fresno and San Jose, are county seats, while the southern two, Pasadena (Los Angeles County) and Anaheim (Orange County) are in the orbit of the Greater Los Angeles complex. Each of the cities was founded as an agricultural community, providing market, communication, and transportation to the surrounding rural area; only Fresno retains this role, and its industrial growth is vigorous as well. Fresno and San Jose elect their Mayors directly, and each Council appoints a City Manager or Chief Administrative Officer to manage city operations; the City Directors or Councilmen in Anaheim and Pasadena elect the Mayor from their number and appoint the Manager. Locations of the Cities and other participating institutions within California are shown in Fig. 3.

The City of Anaheim, surrounded on three sides by neighboring incorporated communities, has nevertheless been expanding into newly-annexed areas along the Santa Ana River and the hills to the southwest, with well-planned industrial and residential zones. It has added new civic facilities, including a stadium, convention center, library, and police and fire centers, which are dispersed about the older portion of the city rather than in a centralized complex. Its industrial constituency included Divisions of North American Rockwell and Northrop Corporation.

Fresno, whose borders are least restricted by neighboring jurisdictions, has grown virtually in all directions. Its commercial center was recently revitalized by the creation of an attractive shopping mall surrounded by parking areas and containing many works of sculpture donated to the city. County, city, and other government facilities, many of them new, are clustered nearby; a recently-constructed convention center is not far away. Continued industrial expansion, much of it in the agricultural-processing field, has increased the demand for civic services and the area of service coverage required. Fresno contained no major aerospace firms as such, but

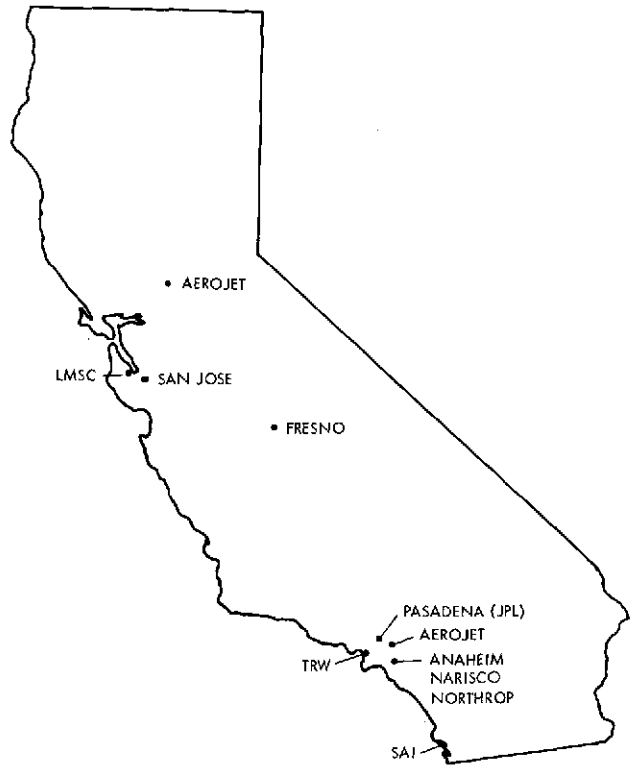

Fig. 3. Location of Cities and Company facilities

had rather early participated in an urban-technology project with TRW Systems, resulting in the establishment of the Community Analysis Division of City government. Dominating the life of its county, and the regional Council of Governments, Fresno faces a complex regional situation arising partly from its growth potential and activity.

Pasadena, the smallest of the four cities in population and area, was and is undergoing profound social changes rather than growth. Long a wealthy residential community with industry limited mostly toward community services and relatively small establishments, the city contains many schools and colleges, including the California Institute of Technology and its Jet Propulsion Laboratory. A number of moderately small, highly technical firms have grown up in the community, and growing minority-group populations have contributed to the dynamics of the town. Housed in a graceful fifty-year-old City Hall, the administration has found city growth relatively difficult because of fixed borders, but nevertheless has expanded and improved public facilities, including new branch libraries and, during the term of this program, a brand-new convention center. The city has undergone a recent surge of commercial growth, and – in common with the other cities – the physical and social profiles of the city have been greatly changed by continuing freeway development.

San Jose, oldest and largest of the cities, doubled its population in the decade of the 1960's, and continues to expand at a prodigious rate. As the southern sub-center of the San Francisco Bay Area, it is party to the resources and megalopolitan problems of that urban complex. Large and diverse industry and commerce and multicultural population mark it as the big city of the Program. A modern civic center near the airport houses city and county governments. A recent community-wide effort to establish civic goals and the continued interest in and support of this Program by the Mayor represent a positive attitude which offsets the scope of the problems posed by sheer size and the rapidity of recent growth.

Political and administrative changes in the four Cities during the two years of the Program have been approximately normal for dynamic communities in the 1970's. A woman was elected to the Fresno Council for the first time, a black to that of Pasadena. John Phillips, Pasadena's veteran City Manager, retired in early 1972, and Donald McIntyre, City Manager of Vallejo, California, was selected to succeed him. T. W. Fletcher resigned as City Manager of San Jose to assume the presidency of an educational organization for city professionals in Washington, D. C., and Ted Tedesco succeeded him. Bruce Reiss of Fresno resigned, becoming Program Manager for local government in the NSF Intergovernmental Science Office, and Ralph Hanley of San Jose replaced him. A prior NSF Program Manager, Edward Lehan, resigned in turn to become Town Manager in North Kingstown, R.I., in early 1973. In the NASA sponsoring office, the original Program Manager, Capt. Kenneth Heising, was reassigned in 1972, and his successor, Lawrence F. Gilchrist, retired in 1973. In the JPL Program Office, the original Principal Investigator, Dwain F. Spencer, accepted an NSF assignment in 1972 and his successor, Lloyd S. Blomeyer, was reassigned in 1973, to be succeeded by Hal Macomber.

These personnel changes are listed together with those in the cities because they form a contiguous pattern of change. Project participants tend to agree that the change of City Managers in three of the cities had the greatest potential of affecting the technology-transfer program, but that in no such case was there more than a temporary interruption of continuity.

B. CORPORATE PARTICIPATION

Each of the industrial firms which participated in the Four Cities Program agreed to provide an Advisor (resident in the appropriate city) whose salary, benefits, and travel expense were to be paid under contract. In addition, the Company was to pay its overhead and supervision costs, and those of supplementary technical support in an amount equivalent to a maximum effort of one man-year per year from its own funds. As noted above, North American Rockwell Information Systems Company voluntarily supported an Advisor in Anaheim for the last four months of 1971 entirely at company expense. Aerojet and Lockheed were under contract for two years each, Northrop for 21 months, and TRW and Science Applications for one year each. In each case, in addition to the Advisor and his cognizant manager, Company personnel participated in studies, consulting work, and the like, in the plant and in the city, in efforts to provide technical help and advice needed by the city, as coordinated by the Advisor. In addition, technical managers actively represented the Companies at Program reviews and meetings, contributing to the learning aspects of the Four Cities Program.

Lockheed Missiles and Space Company was one of the first project participants selected, partly because of its involvement in California's first aerospace technology program and partly because of the innovative volunteer efforts of an off-hours project, called SAGES, organized by the Company's management club. The Company had a background of civil systems study and development efforts under contract, as well, primarily in the information-systems field. Lockheed's Palo Alto Research Laboratories conducted the Company's Program support efforts. Major support was provided in conducting a wide-ranging new-technology seminar series and in training City personnel to conduct an EDP system study.

Aerojet-General, founded in Pasadena but with plants outside the city and elsewhere, has a broad background in rocket and space-system projects, and had performed major civil-systems studies for the State of California among others. Its small Envirogenics subsidiary was first tapped as Pasadena's industrial partner in the program, but Space General (later merged into the Aerojet Liquid Rocket Company) took over the effort before contracts were issued. Aerojet's experience with MBO techniques led it to teach this system to Pasadena.

Northrop's Electromechanical Division in Anaheim assumed responsibility for Four Cities operations in that City in January 1972, continuing the Cable Antenna Television support initiated by the NARISCO Advisor. In addition the Company provided briefings on various other technical and management matters and the survey and study efforts which brought about Anaheim's acquisition of the Hughes Probeye instrument for infrared viewing by fire-fighting crews and other City technical personnel. Northrop also took the lead in coordinating the evaluation of the Four Cities transfer process from the perspective of industry. The Corporation has developed a number of major equipments in the civil field.

TRW Systems Group had performed many civil systems studies and developments at various levels of government, one of which had been the project which created Fresno's Community Analysis Division. This conjunction helped suggest the selection of the TRW/Fresno team as a part of Four Cities. TRW's Advisor, James Wakeman, was the first of the four to take up residence, but his corporate entity remained 200 miles to the south. The Company supported the Advisor on various tasks and projects, but during the first year of the Program its corporate goals and his career objectives appear to have evolved away from the scope of the effort in Fresno, and TRW requested that they not be continued in the Program for the second year.

La Jolla Research and Business Associates, Inc., is a small Southern California subsidiary of the small, young systems-and-consulting firm, Science Applications, Inc. The only participating Company not from the aerospace industry, SAI is

nevertheless staffed with many former aerospace professionals, and the Company's technical R&D and systems-management experience is generally comparable to the aerospace background of its corporate colleagues as a curriculum of value to cities. Energetic out of proportion to its size, the Company actively supported its Advisor's and Fresno's activities, especially in the Waste Management pilot project.

C. THE SCIENCE AND TECHNOLOGY ADVISOR

The Advisor was recognized from the start as the key active factor in the Four Cities transfer process; over the two-year term of the Program, his role became, if anything, more important. He was to hold two positions, nominally, as a professional of his Company and a member of the Manager's staff of his City; an additional informal role, as staff member for the program, developed as the effort progressed. Within the framework of broad assignments from the City Manager, and within the limitations of his capabilities and those available in support to him, his perceptions of city needs and his initiatives were to determine the character of technical transfer to the city. He would be a consultant, a project manager, a medium of communications, and an example: a starter more than a runner.

Accordingly, great stress was laid upon the selection of Advisors for the cities. The companies were to nominate candidates, and the JPL Principal Investigator and the appropriate City Manager were to select each one. Screening criteria were established; they are given in Table 4. The Advisors of this Program are listed in Table 5.

Table 4. Advisor screening criteria

1. Experience of from 8 to 15 years in aerospace, preferably with most of the experience in his present organization.
2. Project (or hardware) systems orientation and experience.
3. Good communications and presentation skills.
4. Strong personal motivation to assist in solving urban problems.

D. PROJECT MANAGEMENT AND COORDINATION

The Jet Propulsion Laboratory was responsible for project management and coordination as well as the provision of additional technical support to operations in the cities. Management activities included an initiatory phase, an operating phase, and an evaluation phase.

The first phase of activity included pre- and post-Proposal transactions with the two sponsoring agencies and with potential participant institutions, the cities and companies. Continuing with this phase, contracts were negotiated; owing to the collaborative-support nature of this Program, contracting operations could become rather complex. The Advisors were selected, and project-wide and individual initial policy and technical meetings were conducted. In two cases, as noted already, contracting and Advisor-selecting operations had to be re-initiated after the project was underway.

Table 5. Four Cities Program Advisors

Name	Company/City	Training	Experience
William Armstrong	Northrop/Anaheim	BS/Phys & Math/ Worcester, Stevens, & Milliken Univ.	Project Engineer, Aerojet Space General; Program Manager and Space Programs Manager, Northrop Space Labs
John Glascock	NARISCO/Anaheim	BS/EE Washington Univ., St. Louis	Comm. Systems Project Engineer, Philco and Lenkurt; Engineering Manager, Info Systems Technology, NARISCO
Michael Licciardello	SAI/Fresno	BS/Engr Sci/ Harvard; MBA/San Diego State	Structural Group, Wright-Patterson AFB; Chief Program Manager, Solar/IHC; Project Leader, National Society of Professional Engineers.
James Wakeman	TRW/Fresno	BS/ME/Stanford MS/ME/USC	Planning/Radioisotope Rocketry, Edwards AFB; Marketing, EOS; Project Manager, Nuclear Propulsion, TRW.
Forrest Warren	Aerojet/Pasadena	BS/ME/Univ. of Texas, San Diego State	Project Engineer, Ryan; Chief Engineer, Aerolab; Program Manager, Satellites Manager, Aerojet/Space General
Jerome Weiss	LMSC/San Jose	BS/Phys/CCNY: MS/Stanford; Math, Psychology	Social Scientist, RAND/SDC; own business; Operations Research, LMSC; Lecturer, Stanford.

The operations phase included contract management activities and general coordination and communication, an aspect of the Program which received progressively greater emphasis as time went on. The contracts provided an option, unilaterally to JPL, for extension of the activity after the first year, and in three cases this option was exercised.

Coordination and intercommunication were formalized in a series of quarterly Program Reviews (Table 6) which brought together representatives of JPL, sponsoring agencies, Cities, and Companies with the four Advisors and various interested and invited outsiders. At first consisting principally of status reports from the four Advisors with news and comments from other participants, the Reviews soon added a panel discussion on a set technology-transfer topic as a principal item. In September 1972 the addition of presentations on technology transfer programs in other cities was begun, and the June 1973 Review was held in the City of Tacoma, Washington. Representatives of many technology-source agencies, government offices, and interested cities have attended and contributed to these meetings.

Table 6. Four Cities Program Reviews

Date	Location	Remarks
Nov. 11-12, 1971	JPL (Pasadena)	Advisors' status reports, discussion.
Feb. 17-18, 1972	Fresno	Status reports and Psychologist's evaluation.
May 18-19, 1972	Pasadena	Status reports, evaluation.
Sept. 14-15, 1972	San Jose	Status reports, presentation on Tacoma program, discussion of Program improvement.
Dec. 14-15, 1972	Anaheim	Status reports, technical briefings, discussion of transfer-process experience.
Mar. 14-15, 1973	Fresno	Status reports, discussion of city's role in transfer, briefings on evaluation plan, Tacoma, DOD consortium, special Fresno activities program scheduling techniques.
June 28-29, 1973	Tacoma	Status reports, including briefings on Tacoma, Kansas City, Montgomery, Philadelphia; Tacoma tours.
Sept. 15, 1973	JPL (Pasadena)	Status reports, extension plan review, briefings on Tacoma, State of California Office of Science and Technology activities. Policy Board Meeting.

A Policy Board for the Program was organized in mid-1973. Consisting of the four City Managers with a JPL Secretariat and ex-officio membership for Tacoma's Manager, California's Lieutenant Governor, and the sponsors (Fig. 4), this Board provided additional communication and coordination between Cities and policy support to the Program management. At about the same time, private meetings of the Advisors with the JPL Principal Investigator, and frequent telephone conferences with and among the Advisors, were set up to increase intercommunication at this level.

Fig. 4. Program Policy Board: T. Tedesco (San Jose), B. Reiss (NSF), H. Macomber (JPL, Secretary), K. Murdoch (Anaheim), D. Delabarre representing Fresno, D. McIntyre (Pasadena) (City of San Jose Photo)

The evaluation phase of Four Cities Program management and coordination, relative to the original two-year term of the Program, consisted of close-out operations on the first-term contracts, (relatively simple because of the nature of the contract and contracted services), Program evaluation, and planning and contract preparation for the future extension of the transfer effort. The latter effort, though it constitutes a considerable portion of the activity, is essentially beyond the scope of this Report.

Program evaluation, though concentrated functionally and chronologically in the final phase of the project management activity, was a continuing effort from the start of the California Four Cities Program. The services of JPL's resident industrial psychologist, Dr. Gilbert Brighouse, were obtained for observation, testing, and evaluation. The Advisors' quarterly reports and the Program's quarterly reviews contain considerable evaluative material. A series of policy questions was drafted, reviewed, and circulated to the four cities and the four companies in mid-1973 for response. The First Annual Report (Ref. 4), the Interim Report (Ref. 5), and this Report contain evaluative material based on these and other analyses.

III. TECHNICAL ACTIVITIES

The technical activities of the Program were carried out principally in the participating four Cities. They were conducted variously by the Advisors, City personnel, Company or JPL personnel, or consultants, or by composite teams of these people. Generally the activities were under the broad cognizance and/or management of the Advisors. The activities of each City were distinct; that is, there were no multiple-city joint efforts, though Advisors and other team personnel made many presentations and other efforts in and for other cities, both in and outside the Program, as requested and arranged with their host Cities.

The technical scope of the transfer activities was not limited at all to the conventional conception of technology or aerospace technology – i. e., hardware, software, production technique. The goals of the Program had been directed toward the transfer process itself, and some of the formal objectives related to activities fostering the process – such as management techniques. Apparently independent of this interest of the sponsors and the Program, the Cities expressed a strong interest in the acquisition of aerospace or industrial management techniques, processes, and devices, such as project control procedures, procurement methods, etc. Thus – partly fortuitously – a significant part of the body of technology transferred to the Cities consisted not of end items, such as hardware or computer programs, but rather of training, familiarization, and innovation in the means of acquiring, adapting, and using such products or processes. At least one such major effort occurred in each City.

The technology transfer activities managed or conducted by the Advisors were classified as major tasks (called "pilot projects"), consulting, and personal support and communications. A pilot project would be initiated in consultation with City officials and formally identified to JPL, and tended to require coordinated support from Company, City, or JPL personnel (or a composite team) over an extended period. Consulting activity was more ad hoc and informal, usually resulting in an informal document or other communication. Personal support or communication was the least formal and most ad hoc, and will be discussed in conjunction with the consultant-type services. The evaluation of these activities is given in Section IVC.

A. PILOT PROJECTS IN THE CITIES

1. City of Anaheim

When Advisor John Glascock joined Anaheim in August 1971, the City was preparing to award a cable television franchise to bring better TV service to those of its citizens who might subscribe. The Advisor reviewed the proposals received, studied the records of other cities' CATV experiences, and recommended an entirely new approach for Anaheim. In due course this was carried out, with technical support from NARISCO, JPL, and Northrop, under the general guidance of two Advisors in succession. Phases of activity included a new study of the potential of CATV communications as a city service system, using both closed and open channels, data links, video two-way, and emergency override of all channels; a new specification and procurement package; help with selection and procurement procedures; a carefully prepared franchise ordinance; and coordination with the selected contractor (Ref. 6).

Additional pilot-project activities of the Anaheim technology-team effort display other possible characteristics of the typical Four Cities transfer project. One, identified early in the Program with priority second to the CATV effort, was called Command and Control, referring to the desire for a unified communications and control system linking Police, Fire, Disaster Services, and possibly elements of other departments. Although technically feasible, this project came into conflict with the principle of departmental autonomy, reinforcing the principle that the first characteristic and achievement of a new system must be its acceptance and compatibility with the user.

A third Anaheim task, originating from a specialized departmental need, became, because of the nature of the solution, something of a cause celebre within the Program and outside, and provided City personnel valuable learning in engineering serendipity as well as a useful new technical capability. At first it was called Viewing Through Smoke; later it took the name of the hardware product, Probeye.

One of a number of technical problems emerging from initial Advisor surveys with Anaheim operating departments was the Fire Department's desire to clear the heavy smoke from certain urban fire scenes, so that crews could see to rescue victims and suppress the fire. Technical consideration of this problem expanded it to that of viewing through smoke, and to the search for a spectral window in the infrared. Further efforts, by a Northrop technical team, uncovered a number of infrared viewing devices developed for military service and being reviewed for civilian uses and modification by, among others, the U. S. Forest Service. The lightest and smallest of these devices was the Probeye, in advanced development in a commercial version by Hughes Aircraft Company in Oceanside, California. Northrop contacted this company, on behalf of Anaheim, and arranged a series of demonstrations and tests, culminating in an evaluation program under City direction in May 1972.

Both simulated rescues and hot-spot location were performed with the prototype Probeye instrument by Anaheim firemen with minimum operator training. This program was a joint Anaheim/Hughes effort, coordinated by Advisor Bill Armstrong of Northrop.

Finally, upon presentation of evaluation results and the value of the innovation, by the Advisor, the City Council authorized purchase of the instrument. The prototype continued in testing and service until the production instrument was delivered (Fig. 5). It was evaluated and used by the Utilities Department as a quick means of checking power transformers for overheating and incipient breakdown and experimentally as a diagnostic tool for internal-combustion engine service. It continues in regular service with the Fire

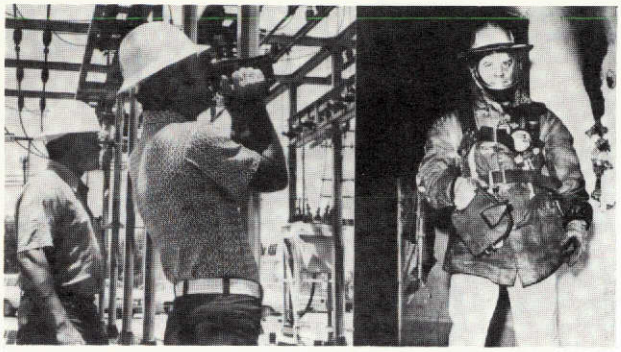

Fig. 5 Probeye infrared viewer being tested in Anaheim (City of Anaheim Photos)

Department, providing a quick method of locating hidden fires through walls, roof, and ceiling panels, and of verifying the absence of a fire without removing panels or searching at length.

The instrument was demonstrated by Anaheim and Hughes personnel for neighboring cities, and further afield through the facilities of the Four Cities Program and Public Technology, Inc., which is presently conducting demonstrations around the country. Like the CATV project, this activity has produced retransferable technology.

2. City of Fresno

The pilot projects initially identified in the City of Fresno were citizen participation in environmental activities and solid waste disposal. The first resulted from a conjunction of the interests of the Advisor, James Wakeman, with the Manager's definition of a City need growing out of rapid industrial growth, citizen concern for environmental values, and national and state environmental policy activities. The second resulted from the projected growth of waste production and extremely limited landfill facilities for solid waste disposal.

The environmental coordination problem appears to have been unique to Fresno in its basic characteristics: rapid and prosperous growth of a rural center, with relatively uncharted conflicts in objectives between transportation, production, commercial, city-beautification, service-development, student, and residential interests; a technical advisor who was an environmentalist-activist; and a changing statutory framework. The principal objective was to improve intercommunication and understanding, and to aggregate the environmentalists in order to feed in their views to policy deliberations. The Advisor served as coordinator between City government and an Environmental Communications Network which was formed as a coordinating umbrella organization of concerned citizens' groups. A newsletter was issued, representations were made to planning bodies, and a City-Council-approved bicycle path program was developed. In addition, the Advisor developed a process for environmental impact statement which was adopted as a standard City procedure. Following the departure of Mr. Wakeman and the transfer of industrial responsibility for the Fresno technology effort from TRW Systems to Science Applications Inc., the citizen organization and its activities became independent of City and program operations.

Solid Waste Management, on the other hand, continued through the two-year term with increasing activity. Reviews of solid-waste disposal techniques, such as pyrolysis, had been initiated by the City and the Advisor, in conjunction with JPL; the new Company (Science Applications, Inc.) undertook an extended system study of the field, and the Advisor organized a Waste Management Conference for City and County officials, with a variety of technical presentations from industry and the Laboratory, expanding the scope to include the recovery of waste from water. Some of the processes were designed to retrieve material resources, such as metals, from the waste; others generated gas to provide a net energy output. In addition, State requirements for regional waste planning were reviewed and related to the Fresno situation, with emphasis on the City/County configuration, waste projections for the agricultural-processing industry, and regional water conditions. Following additional reviews of processes and conditions, the County has assumed responsibility for a specific system study of the problem, making use of City-developed information resources, and requesting the assistance of the Fresno Advisor, Michael Licciardello, as a consultant to the first-phase study effort.

Additional Fresno pilot projects have concerned CATV, city project management, and regional relations. The cable television effort has somewhat resembled Anaheim's, on a smaller scale, while the other two projects call on management rather than technical system capabilities of the company and Advisor.

Fresno's CATV situation differed from Anaheim's in that a franchise had been awarded, FCC approval withheld, and the matter held in suspense for some years before being reactivated with a successor franchise. Much of the Advisor's activity on this project was concerned with learning preparation: researching, and then briefing city officials on the status of the activity, CATV's technical and social potential for government and citizens, preparing for public presentations, and the like. The project remains ongoing.

One need observed by the Advisors and expressed by the Cities, generally and sometimes generically, was for application of aerospace/engineering/system-management techniques to city government activities. In some cases, exemplified by Anaheim's CATV project, and Fresno's Waste Management, these techniques were applied and demonstrated in the course of dealing with technical problems; in others, the indicated need was direct, and the application general.

Fresno needed and could use one of the industrial-project techniques for reporting and displaying the status of the many technical projects – from large-scale industrial zoning to a streetlight addition – in common and comparable form. This City determined that it need not employ a large-scale computer-based system. Advisor Licciardello, reasoning that a simple system could grow but would be immediately acceptable and usable, developed a quarterly project report of simple and clear format. In compact form, its boxed pages presented the essential facts and figures, easily obtained from

the working levels in the departments, so that they could be interpreted and compared by the City Manager and other officials (Fig. 6). According to the plan, the report would not only channel information upwards, but would impose some planning discipline downwards as well. Comparison of similar projects between departments would improve communication, mutual understanding, and technical efficiency. Finally, the report was to be phased over from the Advisor to the Development Department in the course of the first three issues, leaving the Advisor free to study possible expansion of its coverage, or to take on other projects.

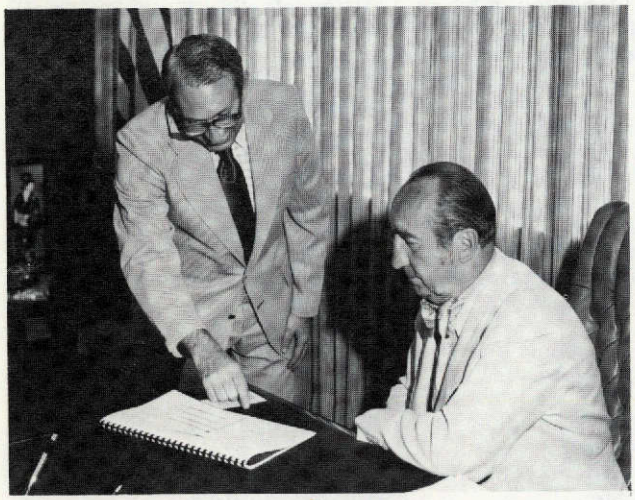

Fig. 6. Mayor T. C. Wills reviews Fresno Project Status Report with Advisor Licciardello (City of Fresno Photo)

The fifth Fresno pilot project confronted the problem of the city's local intergovernmental relations. Dominating the County and the surrounding communities by sheer size, Fresno needed to approach the solution of many technical problems on a regional-cooperative basis; a policy articulation was needed. The Advisor's impartial, nonpartisan status, together with the system-study expertise which the Four Cities partnership was designed to provide to the City, could be brought to bear. After researching and preparing a position paper for the City, and drafting other statements, he partly integrated this task with the Waste Management project as a natural vehicle for regional collaboration and practical coordination. The Waste Management Conference, described above, brought together representatives of other cities in the region, and the Council of Governments, in addition to Fresno City and County officials, and represents a milestone in coordinated activity.

3. City of Pasadena

Pasadena selected, as the original Four Cities plan had conceived, a single pilot project. It was a management-science program, broad in scope and inclusive in design, so that a number of technical projects undertaken in the City served as exercises and examples within it. The project resulted from the City Manager's interest (shared by his successor) in management training, planning, and evaluation on the basis of a unifying system, and the successful experience of Aerojet, Pasadena's corporate team-partner, with such a system, called Management by Objectives (MBO).

Described by Pasadena's Advisor, Forrest Warren, as a style of management rather than a substantive, limited system or technique, MBO works out to be a series of constructs in procedure built around two-way management communication, small-group and one-to-one interpersonal dynamics, and the planning device of committing and performing according to mutually defined objectives. These "objectives," capable of subdivision or translation as the process percolates down through the organizational structure, serve as a basis for codifying and rationalizing productive and creative activities, a task similarly performed by the Fresno internal reporting system. MBO, however, goes much further in requiring supervisor–subordinate conferences, negotiation, and mutual understanding. It also encourages planning innovation on the part of subordinates in the process of objective definition. Through this contact, and the concomitant awareness of group goals and their relevance both upwards to the general program and downwards to specific tasks, MBO becomes a motivating device for supervisory and working personnel. This latter aspect in particular has had a significant impact in some departments such as the Library, whose incoming Director found and remarked upon a staff both informed and motivated with respect to policy goals and improvement aims.

Another effect of the MBO perspective is to encourage the organization of work into projects and phases, which then renders the activities more measurable and reportable. In addition it can improve performance execution, schedule, and even cost, by requiring objective-based preplanning. A multi-level briefing and training program (a typical item of which is shown in Fig. 7) was presented to the city by Aerojet personnel, with follow-up consultation coordinated by the Advisor. The Advisor also participated in a number of departmental projects including ordinance preparation, site survey and planning, and a helicopter-support survey, which served as both test cases and demonstration examples for the MBO style and, simultaneously, for technology transfer and problem-solving through institutional coordination.

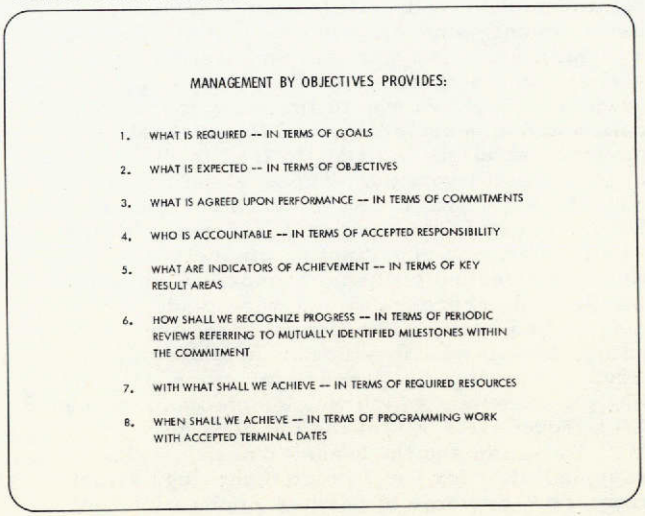

Fig. 7. Typical briefing chart from Pasadena MBO training session

4. City of San Jose

The pilot projects established for San Jose were two in number: A Priority Management program for City projects, and a Municipal Information System. Both pilot projects relate closely to the applied-mathematics and information-system experience background of San Jose's Advisor, Jerome Weiss, and the latter was able to draw on Lockheed's extensive experience in developing civil data and communications systems. The first arose out of the city's consciousness of many problems and projects needing attention, and limited resources available for application, together with the determination to proceed in an orderly manner in solving the problems.

The Priority Management effort exemplifies the role of the Advisor as scientific consultant, even in the handling of an identified pilot project. The nature of the problem, which was to provide a consistent, rational basis for patterned judgments, called for a mathematical modeling scheme of some sort. The Advisor, with the help of Lockheed personnel, searched the technical literature and consulted colleagues, narrowing the search field and identifying a single promising model. Correspondence with the author revealed that his formulation had not yet evolved to the point of application, however, and the project was terminated pending further scientific investigations. Simpler priority management schemes are currently under development by City staff in Fresno and Pasadena.

The Municipal Information System (MIS) pilot project is at the opposite end of the spectrum in complexity, City Department involvement, duration, and external influence. The problem in effect looked toward the rationalizing and systematizing of all possible City data-handling and information activities, with a view to reducing cost through resource saving (particularly in computer utilization), increasing efficiency through standardization, and improving and extending data services. The City's various data services had evolved for the most part independently and irregularly, and tended to be mutually incompatible.

The first step was to organize an interdepartmental Electronic Data Processing (EDP) steering committee (to which Advisor Weiss was appointed chairman) to manage the study. This committee has continued as the coordinating body throughout the program. External sources of information on the progress and methods of similar programs in other cities were sought, without much success owing to program changes elsewhere.

The phased MIS program was then established. The first phase was a survey and planning study, determining all relevant City applications for EDP in the light of current and available capabilities. The main portion of this study was performed by a City team selected from among 120 managers and employees after a training program put on by Lockheed experts. The training curriculum included MIS design procedures, current and potential municipal computer applications, and planning procedures. The remaining portion of the Phase I study, the economic and priority analysis leading to an implementation schedule, was conducted by a contract consultant, retained by the City using procurement and selection procedures introduced (and supported) by Lockheed. This first phase of the San Jose MIS project extended from July to November 1972, involving from 13 to over 100 City personnel, and between five and ten LMSC technologists during training and consultation activity.

Phase 2, the implementation plan, was designed to proceed piecemeal, in order to match a gradual commitment of resources with early partial returns in new operating capability. Of the 27 departmental and interdepartmental applications or subsystems identified, the Position Control (needed by several departments), Fire and Police Dispatch, and Finance Systems were selected for early implementation. A Phase 2 consultant firm (Arthur Young & Co.), was selected, using the procedures employed in Phase I. Rather than attempting to re-invent the subsystems chosen for implementation, existing fire and police dispatching systems, such as the Kustom Electronic complex used in Palm Beach and Seattle, were reviewed for adaptation to San Jose's needs. Potential existing finance EDP systems were also reviewed. This Phase of the MIS pilot project is continuing its progress.

B. AD HOC TASK AND CONSULTATIVE ACTIVITIES

The mixture between major formalized projects or tasks and ad hoc or consultative activity varied considerably from City to City and Company to Company, according to City desires, Company capability, and the approach of each Advisor. For example, in the second year at Fresno major efforts were concentrated in four predesignated problem areas in a successful effort to bring these programs to maturity and, in some degree, to completion, in a short period; in San Jose, however, a consultative approach was taken for both Advisor and Company activities, including a series of topical seminars, with emphasis upon education rather than implementation.

Operating conditions also tended to shape the profile of consultative activities. It was asserted, for example, that Company consultation to Fresno in the first year was limited by geographic remoteness of the Company, while in Anaheim the local company offered more such support than the City departments were ready to use. The company paired with Pasadena moved its corporate home from nearby to the Sacramento area during the Program, but local technical support from JPL continued to be available, and company support to, for example, the MBO project by Aerojet remained unaffected.

In most cases the minor and consultative activities were primarily performed by the Advisor and tended to be shaped by his experience. Since the Advisors were in immediate contact with the City Manager's staff, and Advisor experience tended to include management, this was the direction of most consultative support.

In addition to the management and procurement techniques demonstrated by Advisors Glascock and Armstrong in carrying through the Anaheim CATV project, many overt transfers of management style and technique occurred. These included introduction and modification of a new meeting format, simplified scheduling displays

and planning forms, and, in culmination, the conversion of the City's Emergency Operations Center into a management-control boardroom, where weekly staff meetings are held, with graphics transparency and projection equipment and durable, reusable progress-and-planning wall charts. The Advisor personally designed and constructed the charts and a rear-projection system for this facility (Fig. 8). In addition, the Advisor introduced projection-graphics presentation methods and helped city staff in the development of proposal and documentation techniques.

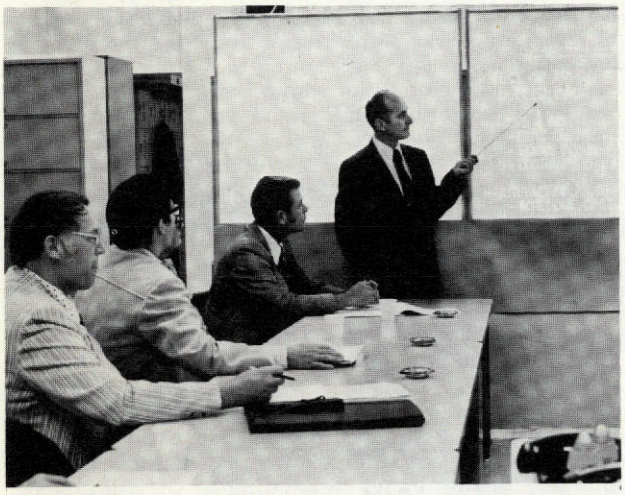

Fig. 8. Rear-projection facility, Anaheim management control room (City of Anaheim Photo)

In Pasadena, in similar fashion, the major pilot project introduced and demonstrated new management techniques, although in this case it was the primary purpose of the MBO effort. Related consulting activities, therefore, quite appropriately took a more technical form, articulating from the management sector toward the solution of departmental problems. The Advisor applied MBO and other management practices to the analysis and presentation of ordinance proposals, supporting the Police Department among others, to facilities siting problems for the Fire Department among others, and to equipment utilization for Water & Power as well as Police. In connection with the Police Helicopter Patrol, he helped with an effectiveness analysis leading to the proposal for a City heliport and with site selection, including noise surveys by JPL on candidate sites. He also developed and built an instrument and system for monitoring neighboring-city support by the patrol (Fig. 9), and helped compile a City manual on effective helicopter utilization. In addition he introduced graphic presentation techniques, and served as Chairman of a City CATV conference.

The first Fresno Advisor's background was in R&D laboratory development and management, and his strongest interest was in the field of environmental problems. Most of his consultative activities were in the field of pollution and waste control, including various ordinance proposals, but he also considered a rocket-powered cutting torch for study by the Fire Department,

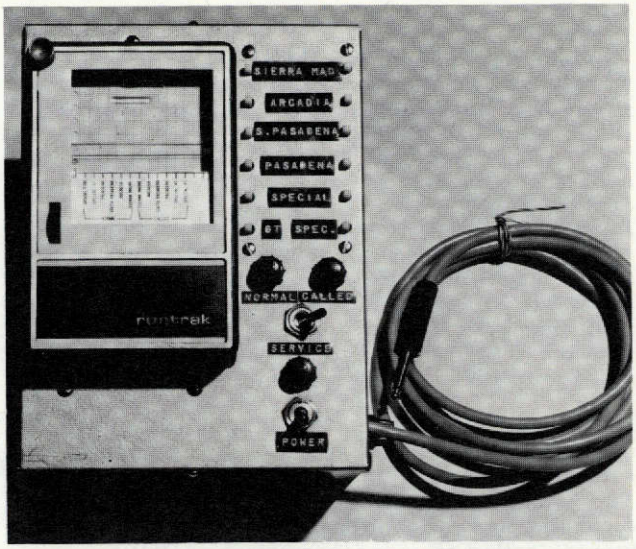

Fig. 9. Pasadena helicopter patrol service monitor (Pasadena Police Dept. Photo)

and arranged for study and development of a vehicle-replacement model, originated by Charles Ware, Assistant Director of Public Works, which was computer-programmed by JPL and used in other cities after being employed in Fresno. The second-year Advisor in Fresno, whose background was in technical marketing as well as management, spent most of his non-pilot-project time as a medium of communication or referral consultant, bringing together diverse City and technical elements to work on common problems.

The San Jose Advisor had the advantage, also found in Anaheim, of a local and very enthusiastic Company. He was able to establish a weekly series of seminar presentations made by various LMSC staff members to the City staff, on a wide variety of subjects, during the first half of 1972. He also conceived a plan for better utilization of graduate-student interns in various parts of the City administration, during two school years. His consultation activities included studies of reorganization plans, smog alert policy, noise control enforcement, vehicle replacement, a minicomputer-based plan for the unified emergency-call system (911), and a variety of other specialized matters.

A number of specific consultative tasks occurred in nearly every city, propagating either through the Program organization or independent of it. The CATV studies in various cities have been noted previously.

One urban analysis technique or model of interest to urban researchers is Forrester's Urban Dynamics model of growth (Ref. 7). Application of this model to the City of Anaheim was carried out by a Harvey Mudd College team, working under the guidance of Advisor Armstrong as a focal point. Application of Forrester's model to San Jose was studied there by Advisor Weiss, and at the same time the City and the Rand Corporation were conducting independent studies of the City's growth.

The development of a mathematical model for analyzing vehicle replacement policies by Fresno's Public Works Department was mentioned above. Following its application in Fresno, the computer program was modified first by San Jose and then by Public Technology Inc. (PTI) to incorporate new factors, and was distributed nationally to City members of PTI's program. Both Fresno and San Jose were able to defer vehicle-purchase costs to a considerable amount on the basis of this model. A site-selection model, developed and programmed by JPL, was used in a Pasadena fire-station siting project, and the same model, calculated by hand, was exercised in Anaheim. Attempted use of the site-selection model provided a key lesson that mathematical models often are unable to account for social and political factors which might have greater significance than technical factors.

Both pilot-project and consultative activities resulted in or contributed to the publication of various City documents. A sampling of these reports and manuals is shown in Fig. 10.

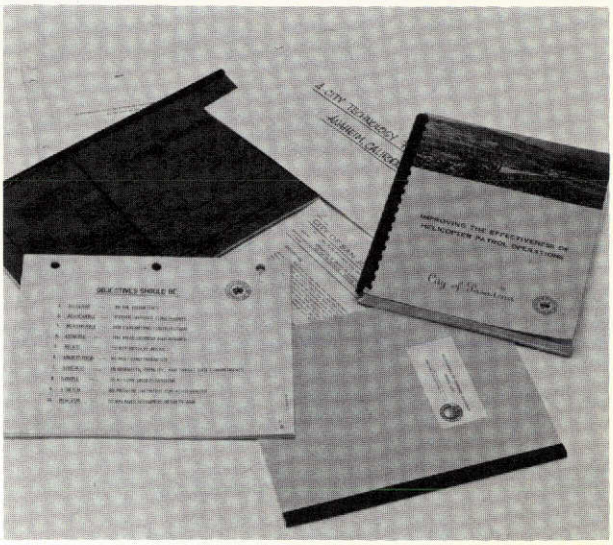

Fig. 10. Representative City documents resulting from Program activities

IV. EVALUATION OF PROGRAM RESULTS

Provision for thorough evaluation was made and maintained in the plans and operations of the Four Cities Program. Consideration was given at the outset to the difficulty of providing a rigorous explicit measure of the outputs of such an endeavor. Further consideration and the progress of events during the Program have revealed only partial solutions to this problem.

As discussed above, an industrial psychologist was acquired as consultant to the program in order to obtain observations on the personal interactions developed as a part of the transfer process. His test and attitude-scale results, covering operations in Anaheim, Fresno, and Pasadena, with comparison data from other sources, were taken only in the second year, although other observations were made in the earlier period. They are presented later in this section, together with the analysis performed.

A system of policy questions was developed and debated in the Program, early in the second year; the plan was presented in March 1973 at a Quarterly Review, and in the ensuing months sets of final questions were submitted to the four Companies, the Advisors, and the City Managers. They were designed to elicit information on the policy effects of the Program upon Companies and Cities, and of operating conditions upon the effectiveness of the Advisors. Various schemes for correlating and rationalizing such data were reviewed (one in the Program's First Annual Report, Ref. 4), but were not pursued as they could not account for the significant intangible results of the Program.

Finally, the Reports and Reviews produced periodically by Advisors, Companies, and the JPL Project Office gave the opportunity for considerable self-analysis and evaluation. The records of the eight Quarterly Reviews (Ref. 10) in particular contain much such material – often casual and very subjective, but nevertheless revealing.

A. POLICY EVALUATION

The plan for formal evaluation by participants, based on the consideration of policy questions from particular perspectives, was developed early in 1973 by JPL, for and with the NSF Program Manager, M. F. Hersman. The policy perspectives envisioned were those of the Federal Government, represented by the two sponsoring agencies; the federal laboratory, represented by the Jet Propulsion Laboratory; local government, represented by the City Managers of Anaheim, Fresno, Pasadena, and San Jose; and industry, represented by the cognizant managers at Aerojet, Lockheed, Northrop, and Science Applications, Inc. Candidate policy questions were developed for each instituiion to consider in the light of the

Four Cities experience. In addition, a group of questions on operating conditions was developed for response by the Advisors.

The policy considerations undertaken by the federal sponsoring agencies are beyond the scope of this Report. Those of the project management, representing inputs to the federal laboratory's decision-making process, are implicit in the general content and conclusions of the Report. The questionnaire on operating conditions was reduced to a single question, though the operating conditions are discussed both in previous Sections and in the psychological review, later in this Section.

1. Industry perspective.

The questions addressed to the industrial participants were reduced to two, after some review among company representatives:

(1) Have any tangible business benefits or potential accrued to the participating companies through this program?

(2) Is the role of industry as a cost-sharing partner in developing the technical transfer process a realistic one?

Generally, the answers were negative: immediate business benefits were not seen, though in some cases future potentials were considered possible, and although the degree of cost-sharing exhibited in the first two years Four Cities experience was endorsed, contribution beyond that level was not considered realistic.

The industrial attitude recognizes their relationship with city governments as potential customers. Generally, the Companies involved in this program are large, needing either to sell a single large item (less desirable and harder to buy) or a mass of identical items (preferable, and requiring an aggregated market). The exception, Science Applications, although a relatively small software-and-consulting firm, was most receptive to the fragmented market situation as it stands. Given the properties of the industry, the responses generally considered the market characteristics of the city with considerable and admittedly new-found knowledge. Finally it should be noted that these responses are not entirely compatible with the active involvement and enthusiasm expressed essentially throughout the program by industry representatives at Quarterly Reviews, and the expressed willingness of the Companies to continue with the program and, under modified conditions which do not include a large operating loss, to participate in its extension.

The Company responses to the policy questions are summarized in Table 7.

2. Local-government perspective.

The city questions, as submitted, covered estimated achievements as well as matters of policy. The eight questions follow:

(1) Does a city need a "Science Advisor?" If so, what backup services are required and from whom?

(2) Is this approach to promoting the use of technology a realistic one?

(3) What technological solutions for increasing local government services and productivity have been brought to the attention of your City from its participation in the Four Cities Program?

(4) Was anything, either hardware or software, delivered to: the City; to other cities; to industries; to sponsors?

(5) Was technology brought into the city accepted and used? Did it bring about change?

(6) What kind of transfer was realized between the cities, industries, and sponsors?

(7) Is the existence of a science and technology program useful in improving local governments use of revenue sharing funds?

(8) Can cities benefit from new R&D relationships with industry? Universities? Federal laboratories? Are the efforts cost effective? Will cities pay the bill if services are required; who should?

The City responses (summarized in Table 8) were generally positive and very penetrating as to the mediating role of an independent Advisor. Any institutional connection which would bring applicable new technology to the city would be beneficial. Tangible benefits to the City, like those seen in 1971-73, would validate the City's sharing the costs. The Revenue Sharing question was premature. The benefits cited included specifics of hardware and software, but the systems approach and other manifestations of the "process" were clearly recognized and cited as important, and potential or future benefits were indicated as well. It may also be seen that the City Managers are well aware not only of Program activities and results in their own Cities but in each other's as well, and that they have thought through the Program's implications thoroughly. The Fresno responses were given by the City Manager Pro Tempore, who previously (and since) has been active and familiar with Four Cities work, and those of Pasadena by the two who held the office through the period being reported.

Summing up, the City managements understand the Program, its benefits, and its implications. They are as hard-headed in considering its economics from their perspective as the Company representatives from their different one. They differ in emphasis, but appear to agree in accepting the innovation or transfer process and its institutional relationships, the need for inter-city coordination, and the shared responsibility to maintain the effort.

Questions developed on the operating conditions were reduced during the review process to a single one: What internal or external influences on the city have occurred during the project period which you consider to be significant that have altered the impact or influences of the project? Responses on file represent only the operations in Anaheim and Pasadena. The Anaheim Advisor found no such significant factors changing

Table 7. Industry policy responses

Respondent	Question No. 1	Question No. 2
LMSC, W. J. Peterson, 6/7/73	Not at this time, though some future possibilities being explored. Time factor precluded early payoff, together with city reluctance towards operational change. However company improved understanding of city for the future.	Limited industry cost sharing in order; in the Four Cities case, the companies have already contributed a reasonable amount.
Northrop, W. B. Simecka, 6/14/73	No measurable business benefit. Possible factor in Anaheim: relative affluence and high state of technology already existing in city. Also: unlikeliness of existing aerospace hardware solving existing city need.	Further participation on a shared basis would not be practical.
Aerojet, F. Warren, 6/20/73	No real opportunities indicated. City contracts usually small, quick-response, bid on by low-overhead groups, thus incompatible with company.	Yes, generally, as new-market investigation and evidence of company's social responsibility.
SAI, M. Licciardello, 6/19/73	Nothing to date. Program of value to company for understanding of city, possible future software opportunities. Reasons below. *	Initially yes, but some trend towards industry benefits should visibly precede extensive sharing.

*Possible short-term business resulting from Four Cities minimized by:

1. Nature of companies, JPL, and sponsors conveys image of high technology, large problems, etc. City thinking must be readjusted to direct Program aid to small, "everyday" problems which actually need and would respond to solution.
2. Apparent reluctance by department heads to really discuss hardware problems, to expose departments to external, possibly political forces.
3. Limitation of resources and lack of incentives for high-rise, innovative attacks on problems which have not yet reached crisis proportions. Little reward for success, heavy sanctions for failure.
4. City decision process not yet related to problem definition or make-or-buy analysis.

In sum, future role of high-technology industry is not clear—particularly clouded by growing involvement of non-profit institutions such as JPL, PTI, RAND.

the impact or influence of the Program, finding most influences relatively stable over the term of operations. He suggested that the program's priority among city matters might be falling as a result of its expected termination at the end of the second year (which did not occur), and/or apparent budget difficulties which do not appear to have developed in fact. The Pasadena Advisor cited the transition phase between two city managers as causing a temporary uncertainty, and delay in implementing the pilot project (MBO) for the second year, but noted a fairly rapid recovery.

The other two Cities each underwent a change of City Manager, and Fresno's Four Cities operation was marked by a change of industrial partner and Advisor, which clearly had a major effect on the impact and influence of the project, not only negatively during the transition but positively thereafter as the new operating team undertook energetically to re-start and recover the momentum of activities. Other changes in management and operating personnel, noted in a previous Section, evidently affected various parts of the Program, but no formal responses were received from participants assessing these changes.

B. PERSONAL/INTERPERSONAL EVALUATION

A primary focus of study, demonstration, and operating in the Four Cities Program was and is at the personal level: the transfer of technology as process occurs fundamentally between people and the institutions they constitute. This aspect of the process was examined by a specialist. His observations, tests, and interpretations form the basis for the material in this portion of Section IV.

Table 8. City policy questions and answers

Question	Anaheim	Fresno	Pasadena[a]	San Jose
1. Is Sci. Adv. needed; if so what backup services?	Yes — independent of city staff; local hi-tech industry.	Yes — integrated into staff but independent of it.	Yes, but "need" is wrong term; known benefits are strong. City back-up support required, as well as technical support. Cities lagging in TU, private sector not filling gap.	Yes — as internal underpendent consultant in technical decisions, focal point for innovative approaches and evaluations.
2. Is this approach realistic?	Yes if (a) fed/state support or (b) cost benefit justifies city funding.	Yes, initially — but TU must eventually be internalized.	Yes — further effort is needed to disseminate results.	Yes, to assure reception and implementation of new technology.
3. What tech solutions has your city learned thru Four Cities?	(a) CATV; (b) Probeye, potential; (c) systems approach to procurement and other decisions.	New information on resource recovery, program reporting, CATV, electric vehicle power. Major benefits in application of old technology — productivity indices.	Education of personnel in problem-solving approach, and significant MBO process (new to city and of lasting value), plus results of specific projects.	(a) Vehicle replacement policy, (b) Computer usage improvement, (c) Improved use of interns, (d) Training of city personnel.
4. Any hardware or software delivered to your city, to others, to industries, or to sponsors?	(a) Probeye to city; (b) CATV learning to others; (c) math models, equipment and facility site.	Project status report — other deliverables scheduled for coming year.	To city — yes; specifics, in software, techniques, and MBO, plus education.	Studies performed for city; product ideas to company; computer approach shared with Fresno.
5. Was technology brought into city accepted, used; did it cause change?	Program has brought about change in city, mostly in management style and operations.	Good acceptance of status report and CATV plans.	MBO popularized Program to Departments, caused changes in approach to problems.	Some accepted/used, some not. Vehicle study, computer usage approach, etc., accepted.
6. What kind of transfer was realized between cities, industries and sponsors?	Intercity awareness, progress, understanding of industry capability and viewpoint.	General between participants. Specifics not known.	Vehicle management, Probeye under study, JPL support to heliport project. Little intercity transfer achieved. In some cities, technology not internalized, just "installations."	Closer city/industry working relations, improved understanding and awareness — computer simulation awareness transferred.
7. Does program help city use revenue sharing funds?	Not really tested yet.	Can do. Software systems (Fresno now has) can help specifically.	Project approach helped in Resource Allocation Survey.	Could have been, but not used in San Jose.
8. Can city benefit from R&D relationship with industry? University? Is this cost effective? Will city pay? or Who should?	Yes to all. Cost eff. yet to be measured. City will pay for cost improvement. Favorable. Would not want captive city employee as S&TA.	Any R&D relation based on sound integrated comm. concepts. Fed/state support necessary to catalyze initial trials, main thrust from within city — will pay when cost/risk favorable.	With any institution, Advisor facilitates use of the institution. Cost effectiveness hard to prove for some cases. Cities should pay part, but there are some benefits to all cities. Inter-city pooling needed. Fed/state support for wide application.	City can benefit from any relationship; efforts to date cost effective. Policy orientation toward mandated work rather than improvement makes cities unlikely ever to pay.

[a]Combined from responses of J. D. Phillips (retired March 1973) and D. McIntyre (appointed March, in office June 1973). The responses of Mr. Phillips are given in full in Appendix B.

1. Conditions of Advisor interaction.

Although the relevant knowledge and skills of the Advisor, and therefore his careful selection for the post, are obviously important, let us first consider the conditions under which he must and can interact in order to bring about the transfer of technology. Some of these relate to the populace, government, and administration of the City taken by itself; some to the working and relational conditions of the Advisor position in City Hall; and some to the multiplicity of roles which the Advisor assumes.

The culture of the City as a whole is a cumulative, pre-existing condition influencing the prospect for change and not itself easy to change. Social change can be subtle or blatant, and public attitudes and image can be quite at variance with the actual situation or needs of the community. Many California cities base their public policy and attitudes with respect, for example, to minority groups, public education, or transportation, on past conditions which no longer prevail. Anaheim, as a traditionally self-sufficient, predominantly middle-class community, with even now quite small minority-group representation, or Fresno, with its solid rural values and sense of harmony with the land around it, might be expected to have difficulty comprehending the vast changes forced by phenomenal urban growth and industrialization. Pasadena, with its major changes in youth/age and racial profiles, has apparently entered a phase of unrest, dissatisfaction, and confusion rather alien to the traditional high-culture and social-grace values which once made Pasadena, according to the Thorndike studies of the late 1920's, the most desirable and culturally advanced city in the nation. San Jose, the oldest-established of the cities, is also the largest, most rapidly growing, and most heterogeneous economically and socially. Yet apparently a lagging budget over the years has limited City staff and efforts to apply new technology. Thus the need and propriety of technical change might be relatively better regarded in San Jose and Pasadena, less so in Fresno and Anaheim. Yet at the same time, the status of high technology in City service at the outset was evidently more advanced in the latter two cities than the former two, owing to City administration and departmental initiatives and to previous external projects, and perhaps as well to the somewhat more secure City environment.

The role of elected city officials in technology transfer is uncertain, and in the Cities participating in this Program it has tended to be indirect owing to the Program's focus on the professional staff. Mayor Norman Y. Mineta of San Jose strongly supported the Program from the outset, and other Mayors have consulted the Advisors; in a few cases, Council members have involved themselves in Four Cities matters. Generally, however, the Program has tended to be relatively remote from the interests of elected city government, as from local business leadership (the group from which most Councilmen are drawn).

The City Manager and his staff, at least partly because this area was chosen as the Program's interface point, and because Cities whose administrations are built around the professional Manager were selected for the demonstration project, appear from Four Cities Program observations to be the fulcrum of technology transfer and change. The fact that uncertainty about the Program's future and about the transfer process has been associated with changes in City Manager (of which there have been three occurrences during the period) is significant. Further, the fact that Advisors' and Company contacts have ranged widely among City Departments and have included non-government institutions, but have continued to focus on the Manager and his staff, further points up the significance of this area as the best locus for the initiation of productive technical change.

Conversely, it must be emphasized that the Manager is balanced delicately between security and progress. As one city officer puts it, "If we do things the way we have always done and something goes wrong, that's an act of God. If we try something new and it goes wrong, we have egg on our faces." While Mayor and Council are answerable to the electorate at the end of each term of office, and most City employees are protected against summary discharge, the Manager is answerable for "egg on the face" to Council displeasure week in, week out. It is a credit to the ego strength and professional and interpersonal skills of any Manager that he will champion innovation, experimentation, and investment in new technique at any level. It might be noted that City Managers generally have professional training, commonly in public administration or political science, and, in one notable Four Cities case, in Civil Engineering. The senior staff members, though less vulnerable, are equally professional, and often become City Managers themselves, as recently occurred from one to another of the Four Cities.

City Departments are more specialized, and though they may be more technically oriented they are likely to be less receptive to interdisciplinary innovation, than the administrative center. Public Safety and Health Departments have had opportunities for technical aid from corresponding special Federal programs, and in some Cities substantial benefits quite unrelated to this Program have been achieved. Generally the Planning Departments have remained uninvolved with Four Cities activities, but in Anaheim and Pasadena especially productive relationships and efforts were achieved by the Advisors with Police and Fire Departments. A paradox of professionalism occurs with the City Engineering and Public Works Departments: professionally the most compatible with the Advisors, they are also the most likely to believe they can solve their own problems and to be preoccupied with the myriad day-to-day matters of normal operation rather than with the possibilities of long-range system analysis. Yet in at least one case — in Fresno, with the Director of Community Analysis and the Assistant Director of Public Works — city-employed engineering professionals have become energetically associated with the Program, to the benefit of both the City and the goals of the Four Cities Program. This case appears to be the exception in Departmental involvement in this technology transfer effort, for the operating Departments tend to exhaust their efforts in meeting daily service-delivery obligations, and are traditionally careful to retain Departmental prerogatives as to scope of effort.

It should be noted that the relational dynamics of local government tend to favor short-term, responsive activity over research and planning. City officials are close to their constituents, and the services their institution delivers are immediate necessities. In contrast, state and Federal governments are relatively more distant, and their service support to the people somewhat less direct. Furthermore, the greater scale of these institutions permits a proportionately small but numerically large quantity of longer-term, slower-payoff R&D activity and systematic long-range planning. Most cities have a few former aerospace professionals or their equivalent, often acquired in the hope of transferring new technique bodily; but the overwhelming demand for immediate, responsive problem-solving prevents these people, like their city professional colleagues, from long-term analysis, problem definition, technique-development, and other activities of this sort.

The second set of critical conditions consists of those which define the Advisor's working milieu. They include the physical environment — how comfortably and near whom he is placed on the job — together with the psychological environment.

The Advisor could be placed in a showcase environment, with impressive facilities and an image redolent of opulence. Since the majority of City personnel have relatively spartan working quarters, such surroundings could be a barrier to successful interaction with the Advisor. In this Program, no such problem exists. The Advisor's office, or desk is generally in no way opulent or even ample. Further, it is often located among professionally congenial City staff, as in Anaheim, where the Advisor was surrounded by a small, vigorous Research and Budget Department, some of whose activities were directly compatible with or supportive of his own Program tasks. Pasadena's Advisor has consistently operated from a small private office off the City's Financial Systems activity, but secretarial support was provided by the City Manager's office on the next floor. In San Jose, the Advisor had an attractive office in the Manager's suite during the first year, where he could hardly avoid frequent informal contact with key personnel. Now he is in the Health Department Building across the street, with some of the Manager's staff. The Fresno Advisor for the first year began by sharing a tiny office with three City employees whose work was unrelated to technology transfer, and then was placed, more comfortably but out of reach, in an annex a couple of blocks from City Hall. The second-year Advisor, sited with Community Analysis, had for some months the use of the Assistant Manager's office while that official was Chief Administrative Officer Pro Tem; he found the improved staff access very productive in both cases. Physical placement can be important, but Program experience shows that active aggressive Advisors can overcome this barrier.

The physical proximity of the Company to the City which it supports (and the Advisor whom it provides) could be of major importance to successful transfer in the City, to the effectiveness of the Advisor, and to the degree of industry participation. Certainly this was thought to be so at the outset and early part of the Program, and the NARISCO/Anaheim, LMSC/San Jose, Aerojet/Pasadena, and Northrop/Anaheim teams seemed to prove the effectiveness of proximity. Some concern was expressed over the 200-mile separation between TRW and Fresno. Later in the term of the Program, the responsible locus of Aerojet was moved to Sacramento, some 500 miles from Pasadena, and a new Company partner for Fresno was chosen, with a headquarters some 350 miles from the City. Company support and the technology transfer process in Fresno appeared to be highly satisfactory; it would seem that distance of this order is not a barrier to such efforts but a challenge to be met like any other.

The complex factors relating to "image" are symbolized by the title by which the science and technology transfer person is to be known. In some quarters it is proposed that he be given an impressive title such as Deputy City Manager. The authority conferred by this title, so the argument runs, would enable this innovator to force progress upon the city. Yet one of the observations which led to the establishment of the Four Cities Program, borne out by experiences during the Program, is that force-feeding technology is futile and short-lived. It was believed, and has been demonstrated, that trust is more important than power in the transfer process as in any educational nexus. Another difficulty is that such a title tends to identify the transfer person irrevocably as a city employee, which he is not, and, as we shall see, evidently should not be. "Advisor" appears to be a neutral, descriptive title which neither limits nor misrepresents the potential of the office.

But whose Advisor? That is, under whose aegis in City government is technology transfer to be fostered? There was some indication in the Proposal for this demonstration project (Ref. 2) that after an initial learning and survey period the Advisor might be assigned to work in a staff or technical Department of the City, away from the Manager. In no case was this option exercised, and in the one case where it was remotely approximated, the Advisor left at the end of the first year, for possibly unrelated reasons. It would appear that retaining the Advisor in a position close to the Manager, so that the Manager and his staff continued to be the "sponsors" within the City of his activity, was a wise choice in each case. The scope of the Advisor's work retained breadth, while he was not inhibited from working closely with the Police Department (e.g., in Pasadena), Community Development (Fresno), Fire (Anaheim), and an interdepartmental EDP activity (San Jose). More important, he was able to be flexible in his attention to specific problems or to the general problem of the City's access to new technique, and to achieve whatever visibility for the systems approach and technical values his own actions could muster, city-wide. Finally, the City Manager, though as we have seen he is vulnerable to the risk aspects of innovation, seems generally — and outstandingly in the four participating Cities — the best placed and most receptive official for the long-term interest and support needed to foster and institutionalize the application of new ideas and methodology.

Against the background of the qualities of the City, residing in its public, elected officials, management, and working departments, and of the Advisor's working conditions, both physical and social, let us now examine the complex role which the Advisor must assume and in which he is perceived by those with whom he must interact.

The role envisioned for and entrusted to the Advisor is by no means unique, though it is a demanding and relatively uncommon one. In its duality of responsibility between executive-administrative and specialist-production institutions, it resembles that of the member of a project team (a role familiar to most of the Advisors) or of a Cabinet Member in most phases of United States history. Briefly, the Advisor is de facto a senior member of the City Manager's staff, but he remains de jure a senior professional of the Company. His day-to-day association is with City colleagues, City issues, City problems and projects. Yet his career future, his technical peers, and much of the working support for his ideas and innovations remain with the Company. He must maintain a balanced identification between these two institutions, bounded on the one side by the "Deputy City Manager" option and on the other by the "consultant" or "Company Representative." (Note that in practice in the Four Cities Program teams there usually was a Deputy or Assistant City Manager and a Company Representative who worked effectively with the Advisor in promoting the transfer process.)

The various Advisors found different points of balance in the operating range between the two institutions, according to their perception of City needs and their own learned modes of operation. One modestly described himself as a general troubleshooter, notwithstanding his having directed a major management project in the City; another as a technical consultant with an extremely broad charter. One, who was physically isolated from his company, seemed to be ideologically isolated from City government, though he identified strongly with the community and populace. Two others, whose Company facilities are even more distant, integrated themselves thoroughly into City Administration while maintaining effective Company integration. The two whose Companies and Cities were close by had no problem maintaining dual ties.

The way in which the Advisor is perceived by City personnel is an essential characteristic of his role: it becomes a part of his working milieu which can strongly influence his effectiveness in bringing in new ideas and techniques. He should be perceived simultaneously as worthy of respect and as a fellow, approachable, "one of us." The interaction of these two criteria is sketched in Fig. 11.

The worthy-of-respect factor is likely to be based on observations that the subject is bright (but not too bright), knowledgeable, well accepted in his profession, successful in his work. The one-of-us factor, principally based upon trust, includes the observation that the subject does not threaten or hold himself superior to the observer, of sense of humor, and of readiness to help the observer. It seems clear that an aggressive high-achiever would rate high "respect" and low "one-of-us" (upper left in the diagram) while an affable, bumbling clown would be in the opposite corner. The Advisor role requires traits leading to being perceived in a central, balanced position. Since the two criteria respond inversely to many qualities (high on one leads to low on the other) it is not easy to achieve positive perceptions along both dimensions. Yet it is demonstrably possible to find such perceptions. This feeling is perhaps exemplified by a Department Head who approached his City's Advisor with an innovation of his own, saying, "If you like it, how about taking it to the City Manager — you have better communications with him."

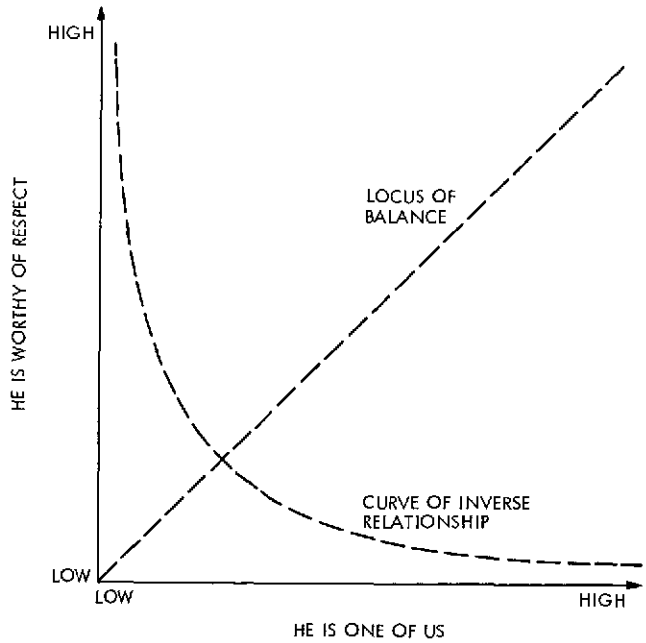

Fig. 11. Perceptions of the Advisor Held by City Personnel

2. Critique of Advisor selection.

The Advisors assigned to foster the technology-transfer process in and to the four Cities of this Program were chosen for that crucial function by screening criteria and a procedure devised deductively in the pre-proposal period on the basis of reasonableness and feasibility. The criteria are given in Table 4. The procedure was simply that each Company was to nominate a number of qualified candidates, from which the City Manager and the JPL Principal investigator would select the Advisor for the appropriate City, after interviews and study of qualifications. No testing or composite scoring was undertaken, just normal hiring practices.

The procedure and criteria were not applied fully and rigorously in every case. Only one candidate was offered Fresno in 1971, and it would appear that in at least one other case the strong motivation and managerial skill of the candidate introduced a large measure of self-selection. At least one candidate lacked the requisite tenure with his Company (although he satisfied the senior-professional criterion), and the experience of others in the aerospace industry, defined rigorously, did not meet the prescribed specification. Each of the exceptions noted was in fact selected for the Program and

performed creditably, some outstandingly. There appears to be little correlation between conformity to the criteria and ultimate performance, though the sample available does not readily support generalizations.

It appears further that the role for which these individuals were being selected was and to a small extent still is in the process of definition, in good part by the Advisors themselves. This suggests that flexibility, initiative, and some amount of creative imagination are needed. The mutability and variety of City needs with which Advisors are confronted dictate that the role is not that of a specialist, nor is it a static one. Willingness and ability to grow professionally, probably in unexpected directions, are indicated. The requirement to deal with, understand, and persuade a broad spectrum of technical and non-technical City and lay persons demands powerful communication and presentation skills and a grasp of "practical" psychology. The criteria called for this ability, but provided no way of screening for it. The field of operations should require some experience in urban community, or at least some kind of socio-political affairs; the criteria specified interest and motivation in this realm, again without a method of discovery. Key human qualities such as warmth, modesty and a sense of humor are equally important in building the interpersonal bridges necessary to this function, but are fairly unsusceptible to measurement and specification, though readily discoverable in interview.

To be able to select reliably for such a configuration of traits would be a boon to many an institution of modern society. The fact that this Program scored as well as it did in selecting its Advisors probably reflects, on the role side, the broad options characteristic of pioneering activities; on the candidates' side, the natural-selection properties of the category, "senior aerospace industrial professional;" on the part of the selectors, the unstructured, well-integrated personnel judgment skills which are an essential part of any successful and experienced Manager; and, finally, a little luck. The pressure on these qualities, particularly the latter two, might be eased by the careful use of some personal inventories, and the expansion and codification of the interview and choice operation. Managers' intuition remains the crucial element of any personnel selection process.

3. Test program and analysis.

To aid in the evaluation and understanding of the essential interpersonal features of the transfer process, certain psychological tests were administered to the Advisors, and a brief, tailored attitude survey was conducted with various City officials, in Anaheim, Fresno, and Pasadena. Successive retesting, e.g., at the beginning and end of the period, was not attempted, and the population sampled is tiny; thus, neither change over time nor statistically relevant class data can be provided. However, to provide a relevant context, test data obtained from a number of JPL engineers associated with various Civil Systems projects, and from a team of Boeing engineers engaged in technology transfer in the City of Tacoma, Washington, are included.

The first test was a series of 40 questions designed to measure attitudes on the Blake-Mouton Management Grid, shown in Fig. 12.

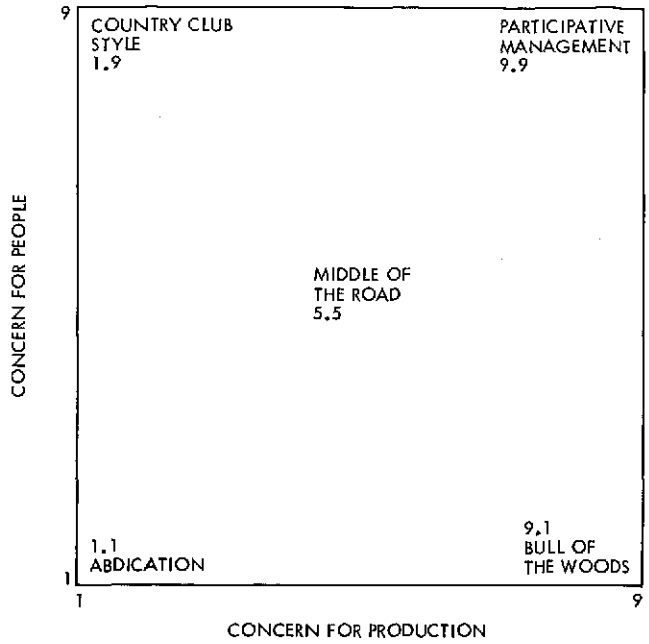

Fig. 12. Blake-Mouton Management Grid

The abscissa scale, with numbers from 1 at the left to 9 at the right, expresses concern for production. Scores on the ordinate, also ranging from 1 to 9, express concern for people and the needs of people. Robert Blake and Jane Mouton identify five particular points on the grid (Ref. 8). A 9.1 score (in these numbers, the abscissa value comes first) would indicate high concern for production and minimal concern for people. It would be the management style of the Bull of the Woods supervisor, but it can also be the management style of those who, in a more subtle way, practice a machine theory of management, and who, therefore, become manipulators of others. A basic assumption of the 9.1 style is that people do not like to work, and therefore, must be coerced, cajoled, or manipulated into performing.

The 1.9 management style is labeled by Blake and Mouton "Country Club Management." The practitioners of this style hope that if people enjoy themselves production will take care of itself. Morale may be high, but it is based on social relationships, rather than on production victories.

The 1.1 position is the impoverished leadership style, in which the manager, in effect, abdicates. His commitment to the tasks is low ("I only work here; I don't set policy"), and much of his effort is spent trying to avoid trouble.

The 5.5, Middle of the Road style, is the common one of seeking the best of all possible worlds through compromise. W. H. Whyte says that of some 60% of managers operate by this style. It is marked by a tendency to rely heavily on tradition and past practices, and to avoid risk. Individual judgment is minimized.

The 9.9 position involves team management. The manager practicing this style places a high priority on ensuring mutual understanding and agreement. He typically has much more trust in others than does the 9.1 manager. He encourages free expression of ideas, and feelings, and gets much involvement.

Blake and Mouton make a further distinction between the dominant style and the backup style. When one cannot always practice one's favorite position on the grid, then one moves to the backup position as a second choice. For example, those who characteristically operate in the 9.1 position, and then find themselves constrained from operating in such a way, as by the requirements of a new boss, typically retreat to a 1.1 position as a backup. In effect, having tried conscientiously to get production, although without regard to the feelings of people, such a manager, on being told that he is not performing right, may move to the 1.1, "Why the hell should I try"? kind of position. Similarly, 1.1 is quite often found as a backup to 5.5.

The Advisors who completed the Management Grid questionnaire were remarkably consistent with each other (See Fig. 13). Each individual scores highest on the 9.9 position, with 5.5 as the backup style. This suggests that the Four Cities Advisors operate in a mode akin to that of the team style leader: he trusts others; he is highly committed to developing goals and involving others in those goals; and he is skilled in communicating. The consistent backup, 5.5, style is probably the most realistic one, and much more effective than a backup to 9.1, which is not infrequently found among managers who try to practice 9.9 leadership, but fall back on 9.1 when the going gets rough.

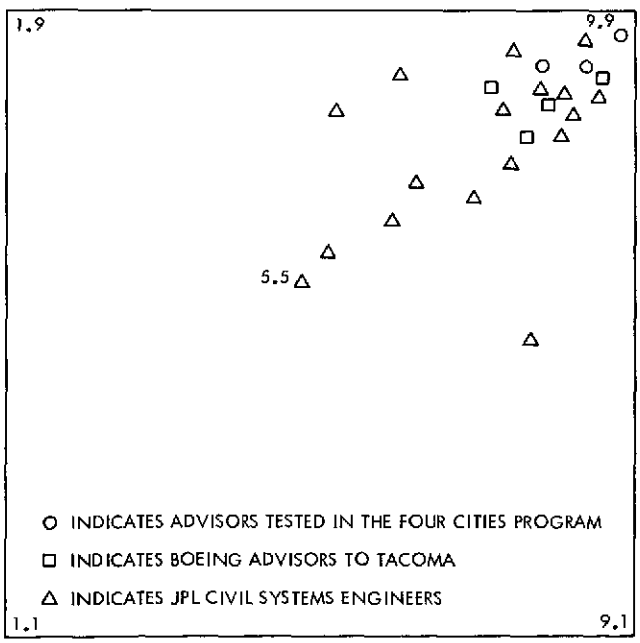

Fig. 13. Blake-Mouton results for Advisors and other technology-transfer engineers

Our sample of JPL engineers engaged in technology transfer shows a marked trend toward the 9.9 to 5.5 axis, with more of them nearer 9.9 than 5.5. One shows a 9.1 backup and two show 1.9.

The Boeing engineers at Tacoma are remarkably like the Advisors in their clustering near the upper right hand corner of the chart.

The other test completed by the Advisors was the Myers-Briggs Type indicator (Ref. 9). This set of 166 questions is based upon the psychology of the late Carl Jung. Jung pointed out that very early in life each of us develops habits of perception, and, therefore, ways of operating to which we become so habituated that they seem to us to be the only right way to view our world.

Jung described several dimensions, and the Myers-Briggs Type Inventory gives a measure of four of these, with a position at each end of each of the four dimensions, yielding eight scores. The most widely known of these dimensions is Introversion-Extroversion, the habits of being, on the one hand, more responsive to inner urgings, and to the data coming from past experience; and on the other hand, to respond more to external stimuli. Most of us are ambiverts, meaning that we turn both ways, perhaps at different times of the day or week, and at different ages and different social situations.

The Advisors are not nearly so consistent on this test as they are on the Management Grid. One scored highly extrovertive; one high introvertive and one ambivertive. All are highly regarded in their respective Cities and appear to have achieved highly in this Program. This suggests that the Advisor may be successful in achieving technology transfer with any of these positions. This finding is consistent with other evidence that successful executives also run the range from extreme introversion to ambiversion to extreme extroversion. We have a sample of thirty JPL engineers engaged in technology transfer and they too run the gamut from introversion to extroversion as do the Boeing engineers, as shown in Fig. 14.

The second dimension in Jung's scheme is labeled "S" for sensory and "N" for intuitive. The sensory orientation involves a heavy reliance on those data which are either currently entering through the sense organs or which have come in in the past, and are used in the forms of memory, inference, assumption, etc. An intuitive orientation means that relatively less attention is paid to the data of the senses, and relatively more to materials from the unconscious, appearing in the forms of intuition and creative imagination.

The Advisors tend toward the middle of the scale, suggesting that they characteristically include in their thinking and decision-making both sensory and intuitive data. In this respect, they occupy a middle position between executives, who ordinarily score much higher on the sensory end of the scale, and many design engineers, who frequently use a relatively large proportion of intuitive data. The Boeing group shows a similar tendency to the Advisors while the JPL engineers show a heavy weighting at the intuitive end of the scale.

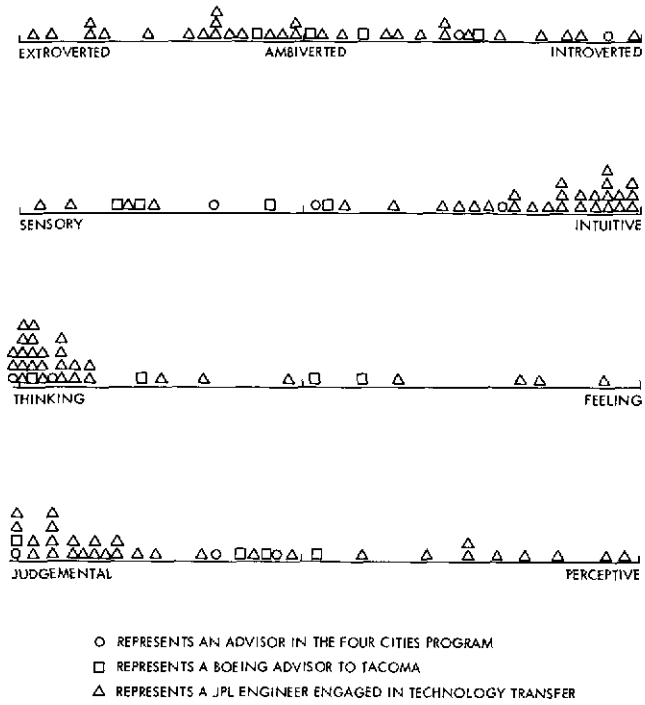

Fig. 14. Myers-Briggs Inventory results

Jung's third dimension is Thinking-Feeling. A thinking orientation means that one pays more attention to intellectual, rational, logical kinds of data, often with a strong preference for quantitative information. A feeling orientation implies the opposite — that one pays relatively less attention to rational data, and is more sensitive to the world of feeling, both in oneself and in others.

The Advisors fall very strongly at the thinking end of the dimension. This places them more like executives and engineers, and less like psychiatrists, pediatricians, poets and merchandising people. Among JPL engineers and also the Boeing men, the thinking end again predominates.

Jung's fourth dimension is from Judgmental to Perceptive. Some people learn very early in life to judge what they experience — "That's bad"; "He's a good man," etc. Others characteristically enjoy experience for itself without judging, and if they have to make decisions based upon judgment, prefer to wait until the data are all in. From the point of view of someone at the perceptive end of the scale, a highly judgmental individual may appear to make up his mind too soon, and to be rigid in holding onto his opinions. From the point of view of someone who is strongly at the judgmental end of the scale, an individual at the perceptive end of the scale may appear to be unwilling to make up his mind, and indecisive.

One of the Advisors scores at the extreme Judgmental end of the scale. He has achieved particularly high acceptance in the City in which he is working, partly because of his willingness to make decisions quickly and stand back of them. The other two Advisors score in the middle of the scale, supporting a speculation that while a high degree of the judgmental orientation may accompany successful work as an Advisor, it is unlikely that a high degree of the slower, perceptive orientation would do so. However counter-examples exist outside the Program.

The data from the Myers-Briggs type inventory can profitably be viewed in the form of a 16-cell chart, as shown in Fig. 15. Many successful managers and executives are found in the upper left (ISTJ) and lower left (ESTJ) squares. Myers and Briggs (Ref. 9) give this capsule description of those scoring ISTJ: Has depth and concentration; is thorough and respects detail; is realistic, analytical, logical; has organizational skill. They describe ESTJ individuals as follows: At ease with his environment; practical; relies on experience; logical; decisive; has organizational skill. Many design engineers are found in the upper righthand box (INTJ), described as follows: Original, analytical, has a critical faculty; individualistic, rich in ideas. One of the Advisors scored ISFJ, described as follows: Has depth and concentration; respects detail; has sympathetic understanding of people; is considerate of the common welfare; is likely to have artistic taste and judgement. One scored, INFP, described as follows: Has considerable depth; is ingenious, adaptable; has a capacity for devotion and sympathy; is curious about new ideas; persuasive in the areas of his enthusiasms, which are quiet but deep-rooted.

		SENSING		INTUITIVE	
		THINKING	FEELING	FEELING	THINKING
INTROVERTED	JUDGMENTAL	△ △ □		△	O O △ △ △ △ △ △ △ △
	PERCEPTIVE			△ □	△ △ △
EXTROVERTED	PERCEPTIVE			△	△ △ △ △
	JUDGMENTAL	O △ △ □	□	△	△ △ △ △ △ △ △ △

O FOUR CITY ADVISORS
△ JPL ENGINEERING ENGAGED IN TECHNOLOGY TRANSFER
□ BOEING ENGINEER WORKING WITH TACOMA

Fig. 15. Myers-Briggs 16-cell grid display of results

In the attitude survey, the City Manager was asked to complete a form indicating acceptance or rejection (by degrees) of four statements about the Program and its results, and to ask his Deputies/Assistants and Department Heads to do the same. Respondents were also asked to add their own comments, of any kind, and to separate them from the questionnaire. The attitude-scale results are given in Fig. 16, and the comments are listed in Table 9. The respondents and their Cities are not identified, but the results from each City are symbolized distinctly and clustered to permit analysis.

Clearly, the general response to the Advisor has been favorable in each of these three Cities. However, more impressive than quantitative data are some intuitive observations based upon informal visits by the psychologist with City personnel,

STATEMENTS	COMPLETELY DISAGREE -2	GENERALLY OR PARTIALLY DISAGREE -1	INDIFFERENT OR UNSURE 0	GENERALLY OR PARTIALLY AGREE +1	COMPLETELY AGREE +2	MEAN SCORE
1. TECHNOLOGY TRANSFER HAS MADE VERY VALUABLE CONTRIBUTIONS TO OUR CITY	○		○	○○○○○○○	○○○○○○○○○○ ○○	+1.4
				□□	□□	+1.5
			△	△△△△△△	△△△△△	+1.1
2. I DON'T SEE THAT WE HAVE GAINED ANYTHING FROM TECHNOLOGY TRANSFER	○○○○○○○○○○ ○○○○○	○	○	○○	○○	-1.2
	□□□□					-2.0
	△△△△△△△	△△△	△	△		-1.3
3. OUR CITY GOVERNMENT IS GENERALLY RECEPTIVE TO NEW IDEAS	○			○○○○○○○○○○	○○○○○○○○○○	+1.4
					□□□□	+2.0
		△	△	△△△△△△△△	△△	+0.9
4. THE SCIENCE AND TECHNOLOGY ADVISOR IS VERY COOPERATIVE WITH THE CITY				○	○○○○○○○○○○ ○○○○○○○○○○	+2.0
					□□□□	+2.0
				△	△△△△△△ △△△△△	+1.9

Fig. 16. Attitude-scale results

Table 9. Comments elicited with attitude survey

It has encouraged us to analyze our Department with an approach of developing new and better methods of performance.	We need more interpersonal information transfer.
I have no suggestions. Our advisor has been beneficial to the Water and Power Department.	We need to send more people to transfer more and varied information faster. Technology transfer information has been meager and slow.
We need more men like our advisor made available to us.	We need to develop more efficient procedures for the delivery of basic services to citizens.
Our advisor has contributed to the success of this program, and is, by virtue of his dedication and professionalism a key factor in the effectiveness of this undertaking.	Two of the most outstanding benefits we have received from the technology transfer program has been: (1) The development and understanding of a Management by Objectives Program, along with a better understanding of the interrelationships of the various departments of the city; (2) the awareness of proper graphic and visual aids in presenting our program to city management, the public, or to outside organizations.
There have been several excellent ideas (my opinion) suggested by the advisor, but they have not received necessary support from the City Manager or his immediate staff, due to either fiscal or personnel limitations. The past administrations in our city have been ultra-conservative in respect to properly funding all maintenance efforts, and have tended to resist innovations, particularly those from outside the city.	In my opinion, this program has made a valuable contribution, and should be continued.
Technology transfer is hard to apply to a small department where work is of an unpredictable, emergency nature.	Continuation of the program under federal sponsorship.
	More emphasis on the direction of efforts by a City Manager's steering committee and de-emphasis on direction by JPL.

Table 9. Comments elicited with attitude survey (Cont'd)

We need one-day, quarterly conferences.	individual is assigned. Thus, the advisor's role should be one of solving the stated problem, rather than working on make-work projects. Make-work projects are good in some cases, but a specific assignment is more beneficial to all concerned.
We need the advice and assistance of Dr. Blank of the Jet Propulsion Laboratory related to findings to improve the program.	Reduce the concern with hardware, and balance with systems approach indoctrination and assistance.
A major barrier to productive interface between technology transfer personnel and local government seemingly rests in the limited knowledge of lay people concerning available products of space technology. Trite though it may appear, we remain among the uninformed in this Buck Rogers era. Unfortunately, our ability to request solutions is a direct function of knowledge of the solutions available.	This department has not been sufficiently involved with the technology transfer activity to be able to make an informed evaluation of its ultimate contribution. However, from participation in staff discussions, I have been favorably impressed with the advisor's approach to the solution of problems.
We must redefine and identify real goals of the program, and move for specific attainment.	We need more direct communication between the advisor and the department. More direct involvement with departmental activities would be helpful to us.
I think we need a more effective method of using the Science/Technology Advisor. I feel we should really "turn him loose" in our city. Let him actually get out in various departments to see what goes on with the idea of this being that such activity will stimulate new approaches and methods of doing the work. It is a good program, and should be continued.	Technology transfer activity should be programmed by JPL. "Instead of having a recreation expert show up at a party, he should have come up with a schedule of games to play." Perhaps cities don't know where their problems or needs lie. The 12 hours I had alone with our advisor helped move our problem-solving years ahead, but our sessions were a result of luck, rather than planned.
A Science/Technology Advisor should be available exclusively to the Police Department for a six-month period to assist in planning and development of computerized communications and informational system.	The new proposed program in our city, if followed up, should respond more fully to the needs associated with our activities here.
Actual work for the Science/Technology Advisor should be spelled out and agreed upon before the	

and attendance at some of their meetings. These suggest a wide variation in answers to Question 3. In one City, although city personnel say of the Advisor, "He's a nice chap," "he's a bright man," etc., most of them show little enthusiasm for change, and seem content to operate as they always have. At the opposite end of the scale are two Cities in which only a minority of Department heads and subordinates seem resistive to new ideas. Here, a majority show a high esprit de corps and an enthusiasm for the development of new ideas. Some typical comments are as follows: "I used to dread to come to work, but this is an exciting place now." "This city has sure changed in the last two years, and I like what I see happening." "We had ideas of our own before, but now that we have this man here with us, it is much easier to get suggestions accepted."

The opinions of the Advisors vary on the question of what the program has done to/for them. The majority feel they have learned much. "This experience has opened my eyes. I had had no idea of how complex a city really is, nor of how challenging the work could be." At least one current Advisor has become so deeply involved that he is giving serious consideration to the idea of making city work his career, rather than going back to aerospace. Those who are going to return to engineering work in aerospace feel that they have learned a great deal.

There is at least one who fears that if he stays longer away from his chosen career in engineering that he will get too far behind, and may lose out in the race for promotion. He has chosen to return to his Company, but in a management role which draws on his City experience to help his Company toward civil and urban-system activity, rather than a "return" to aerospace engineering.

C. PROGRAMMATIC EVALUATION

The two modes of Program evaluation whose results are reported in the preceding subsections address questions of evolving views of what should be done and the personal performance and interaction of individual Four Cities participants. These studies yield insights toward an evaluation of the form of technology process fostered and demonstrated in the Four Cities Program, but they do not directly offer measurements of the effectiveness of the Program or the embedded process.

A different methodological approach, undertaken at this point, directly addresses program performance and offers an additional perspective—an external one—on the effectiveness of the process. Its sources of data are varied: reports prepared in the course of Program activities, and records of the Quarterly Review meetings, together with certain indicative events and representations from the Cities. This evidence supports the contention that the process focussed upon in Four Cities is a productive one.

Progress reporting was specified for the Four Cities Program for a number of reasons. The first was simply to provide evidence of performance under contract, to validate payment to the contractor Companies. A second reason was to provide a record of activities for reference as

an information base. Another reason was to formalize one medium of project communication.

Reports from the four City/Company operations included a quarterly progress report, prepared by the Advisor and approved by the cognizant City Manager; these were addressed to the JPL project office and distributed to the sponsoring agencies. Their essential scope was the activities of the Advisors in their Cities, with collateral material on related city and/or company activity as appropriate. A semiannual report was prepared by each Company and forwarded to JPL through official contractual channels. This document included, by reference or enclosure, the Advisor's quarterly reports for the period, together with accounts of Company support efforts.

These reports, general specifications for which were defined at an early Quarterly Review, varied widely in treatment. They range from a highly structured document containing a detailed chronology, a thorough topical analysis of significant tasks, a time budget, and a discussion of future plans, provided regularly by one Advisor, to a discursive memo or letter report, addressed to the City Manager, containing a review of Program matters and brief analyses of specific problems and tasks. The Company semiannual reports varied in much the same way, from a succinct letter transmitting and adding to the Advisor's quarterly reports to an extensive document containing the results of Company studies performed to support a City pilot project as well as the formally required information. The quarterly documents from the first-year Fresno Advisor were somewhat irregular as to schedule, but all other progress reports were generally quite timely. The most comprehensive as to information presentation were those prepared by the Northrop/Anaheim Advisor, but none of the reports was inadequate in this respect.

The summaries of activities, both successes and failures, given in Section III above, are based principally upon these reports. Evaluative commentary in the reports was usually expressed freely, ranging from "this was well received" to extended analysis of City conditions and attitudes, recommended policy and approaches, and reportage of comments and observations of third parties. From early in the Program to late, there is evidence of progressive growth from familiarization with the City character, to integration of the Advisor into the City milieu, to operational progress and completion of tasks.

The eight Quarterly Reviews of the Program, modeled after NASA project practice with the intent to provide a two-way reporting medium, to foster inter-City interchange of views and ideas, and to reinforce team consciousness, offer a broad scope of material for evaluation as well as many critical comments. Comparison with other plans and programs was fostered by the practice of inviting representatives of other cities and agencies to attend and outline their technology-transfer ideas and progress. Each meeting also contained a discussion period, which soon evolved into a panel discussion on a policy subject. Changing views on various policy questions, as the Program evolved through various phases, were expressed in these meetings. Abbreviated records of these deliberations were compiled by JPL (Ref. 10).

The first evaluative datum which can be extracted from the total body of discussions held during the Quarterly Reviews is the continued process of learning and reflection by the Advisors, City personnel, and Company representatives, even during the later periods when operations on pilot projects and consultative tasks were underway in large numbers and at high rates of effort. Some results of these reflections were presented to professional societies (e.g., Ref. 11).

A second important datum is the adaptive, fluid nature not only of the City-team operations but of the Program itself. Notwithstanding the explicit project objectives (Tables 1 and 2) and other explicit role statements defined at the outset, changing conditions and understanding brought about changes of role or at least of emphasis for the Four Cities Program.

Third and probably most important was the partial inadequacy of the formal review process itself. The model for the Quarterly Reviews had been predicated upon an evolved relationship between reviewer and reviewee—those hearing and those speaking the substantive status and progress information—which did not exist, or at least was not perceived, among the participants of this Program. There are many such relationships possible, from peer-group/colleague through court/advocates to supervisor/subordinate. Despite, and perhaps partly because of, the independently-acquired management skills of the various Program participants, a compatible set of review-process roles did not develop early in the Program, and some difficulties in communication did develop. Late in the first two-year phase, special attention was addressed to this aspect of the Program, and certain organizational changes, notably the formation of the Policy Board, led toward more effective review and management communication. There is no indication that the essentially independent operations in the Cities suffered from any major problems of communication.

Finally, the report documents addressed by the JPL project office to the sponsoring agencies include a first Annual Report (Ref. 4) supplemented by two preliminary Activity Reports, an Interim Report (Ref. 5), and this Report. These documents tended to be cumulatively inclusive (i.e., each one incorporated and superseded the material of those preceding), contained progressively more evaluative material, and are not to be evaluated here. Parts of this document are derived from the earlier reports cited.

The accomplishment of specific designated pilot projects in each City, described in Section III.A, provides a further measure of Program achievement. A status evaluation summary of these pilot projects is given in Table 10. In addition, a large number of activities not designated as pilot projects (described in Section III.B) also contributed to the Program's product list.

External events can and should be interpreted as partial sources for the evaluation of the Four Cities Program, as well as internal events. The decision of the National Science Foundation to sponsor, and of the Four Cities to cosponsor, an extension of the Program for at least one year, and of the four Companies to participate in this extension, constitutes a measure of the local

Table 10. Pilot project status evaluation

Project	Status, late 1973	Results
City of Anaheim		
CATV Management	Franchise awarded, franchisee awaiting final FCC approval.	Model franchise ordinance completed; city government service features and subscriber features designed.
Command & Control	Studied, developed, and terminated.	–
Probeye	City-purchased instrument in regular Departmental service.	New high-technology hardware acquired by City; cost savings noted. Studied by other Cities.
City of Fresno		
Environmental Organization	Low level of activity after vigorous operation in 1972.	Impact statement in City procedures.
Waste Management	Taken over by County after development, technical studies under City; master plan study in process.	Local conference held; studies of advanced disposal/recovery techniques disseminated. City/County coordination.
CATV Support	In process.	Information, planning, preparation for public education.
Internal Project Reporting	Developed and operating.	Internalization to City Department; project management orientation for reporting and using elements.
Intergovernment Relations	In process.	City position papers; intergovernment waste project (above).
City of Pasadena		
Management by Objectives	Adopted, exercised in second annual cycle.	Improved staff/management relations, awareness, operations attested by participants. Many requests for MBO briefings from other cities.
City of San Jose		
Priorities Management	Researched, terminated (no math model extant).	–
Municipal Information System	Phase 1 completed, Phase 2 in process.	EDP steering committee, City system study, EDP applications identified and ranked, implementation consultant selected, applications contractors and systems under review.

success of the effort, together with an implied recognition that the initial term of two years was insufficient to fully explore the process of technology transfer in local government.

Further, the undertaking and Federal sponsorship of Public Technology, Inc., in its proposals to establish broader versions of a Four Cities-like program, should be regarded as an endorsement of the thesis this Program set out to demonstrate. Interaction of other city technology programs with Four Cities, notably the Totem One effort in Tacoma, Washington, and indications by representatives of other cities of valuable inputs received from this interaction (again, notably, Tacoma, in the matter of CATV strategy) are further measures of Four Cities productivity.

Particularly with respect to pilot-project results, secondary propagation of Four Cities technology serves as a measure of performance. Three examples highlight the retransfer process:

(1) The city of Glendora, not far from Pasadena, learned of the latter city's adoption of the MBO technique as a Four Cities effort through informal communications, requested and received an introductory seminar on MBO, and began negotiations with Pasadena to acquire training from Pasadena's Advisor. The Advisor was also invited to describe MBO theory to the City Clerks session at the League of California Cities' 1973 Annual Meeting.

(2) Probeye infrared-viewing applications and test results were disclosed to Public Technology, Inc., and to a number of neighboring cities by Anaheim, which had tested and acquired the device in a Four Cities pilot project. A number of Southern California cities studied possible use of Probeye, and PTI has demonstrated it to several other cities outside California.

(3) The mathematical model of the problem of vehicle use and replacement, conceived and designed by Charles Ware of Fresno and programmed for computer operation by JPL as a Four Cities support task, was shown to other cities in the Program and disclosed to PTI which reviewed and revised the model, improved it by adding new factors, and re-propagated it to new cities on a national scale.

Formal notice was taken of the Program by various members, levels, and agencies of government. In each case, these events served to disseminate the principles and some of the results of the program to interested parties, somewhat in the manner of the attendance of visitors at Quarterly Reviews, and to propagate specific project results. In chronological order, these interactions include:

(1) A 1972 review of the Program by the President's Science Advisor, Dr. Edward David, Jr., and a request that JPL prepare a plan to extend the Program to a national scale; the plan (Ref. 12) was submitted November 30, 1972.

(2) A special presentation, requested by NSF, of Program status and progress to a group of Federal officials, in Washington, D.C., February 28, 1973.

(3) A presentation on request, to City and County officials in Huntsville, Alabama, March 5 and 6, 1973.

(4) Description of the Program as an effective example of technology transfer by Mr. Alfonso Linhares, Chief of R&D Policy Analysis, Office of the Secretary, Department of Transportation in an address in Pittsburgh, Pa., June 13, 1973.

(5) Description and commendation of the Program by Senator Alan Cranston of California, introduced into the Congressional Record, June 21, 1973.

(6) Invited testimony before Senator John Tunney of California's Science, Technology, and Commerce Subcommittee of the Senate Commerce Committee by Mayor Norman Y. Mineta of San Jose and Dr. William H. Pickering, Director of JPL, describing the Program in the context of successful technology transfer, respectively in San Francisco on August 31 and in Los Angeles on September 4, 1973.

To place a monetary value to the Cities of the Four Cities Program is difficult on a general scale, because both changes in attitude and behavior and additions to city procedure and service, particularly those of long-term worth, are capable only of subjective evaluation. But a number of specific cases in the Program, those in which skilled assistance and those in which new techniques or equipment saved money, can indicate in a fragmentary way the direct monetary worth of technology introduction to the city administration. The consideration of these figures contributed to the decisions by the four Cities, in the Fall of 1973, to appropriate funds for the continuation of the Program.

The intervention by Four Cities team personnel in Anaheim's acquisition of Cable Antenna Television brought the city a ten-channel communications service package, estimated market value $300,000 per year, at no cost; alternatively, the consultant services afforded to Anaheim, and resulting in this highly satisfactory CATV franchise, are estimated to have been worth $100,000. The value to the cities of Pasadena and Fresno of support in CATV investigation and development is less susceptible to such a determination, being still in process.

Consultation on vehicle management and replacement policy led to cost savings in Fresno and San Jose. In Fresno, the mathematical model developed for vehicle maintenance and use analysis was used to provide evidence for longer retention of vehicles, deferring costs estimated by the City Manager at more than $200,000 the first year and more than $100,000 the second year. A similar study, established by the San Jose Advisor and performed by a student intern, on replacement policy for police vehicles, saved an estimated $60,000 per year.

Police-activity consultation in Pasadena, aimed at the reduction in false alarms from burglary/robbery detection systems, has saved the undetermined cost of a large percentage of alarm-response actions. There has been nearly a 40 percent reduction in false alarms as result of this activity. Helicopter patrol improvements, still underway, are expected to provide substantial cost-saving returns when completed.

Anaheim's Probeye instrument, now in Fire Department service, has already reduced the time and property damage attendant upon the location of hot-spots within buildings. The Department estimates it will potentially save at least one residence per year; life-saving values are difficult to calculate. When used in utilities equipment inspections, the same instrument replaces leased test equipment at a cost savings of $2000 per year.

The San Jose Municipal Information System Study, the first phase of which was largely performed by Four-Cities-trained city personnel, obviated additional consultant costs; system procurement cost savings resulting from program intervention are estimated at 10–20 percent.

Savings nearly impossible to specify have certainly resulted from the introduction of certain management techniques in each City by the Advisors. For example, the methods introduced for maintaining current the status of the large number of projects in process in each City provide the capability for efficient control and use of the City's limited resources and a more timely delivery of the services provided by these projects. Efficient management of these projects must result in cost savings.

V. CONCLUSIONS AND RECOMMENDATIONS

The California Four Cities Program is a successful demonstration of technology application from the aerospace industry to local government, a fruitful exploration of the parameters of the special process required and of the needs and capabilities of the types of institution involved, and a learning process whose lessons have begun to propagate beyond the inner circle of participants. The formal objectives have been met, and in some respects exceeded, despite the general lack of rigor in the basic theory, incomplete understanding of the parameters of the working urban situation and difficulty in quantifying the observations of progress.

The achievements of the Program should be attributed largely to the interest and willingness to cooperate on the part of the City Managers and their associates, of the participating Companies, and most especially of their representatives who served as Science and Technology Advisors to the City Managers. That is, the activities of this transfer project were fundamentally management/personnel activities, and their success is largely due to the quality of personnel involved at each operating focus.

The specific conclusions arising from this program are organized topically, first within and then beyond the scope of the established objectives; finally, a number of general recommendations deriving from these conclusions and the experience of Program operations are given.

A. CONSIDERING THE OBJECTIVES

The specific objectives prescribed for the California Four Cities Program are listed in Table 2. They take the form of applied-research ("to determine"), education-training ("to expose") and engineering-test ("to assess" and "to evaluate") goals. Fulfillment of some of these objectives results in practical accomplishment rather than informational conclusions. However, the nature of the Program approach and effort on even the education-training goal permits the association of conclusions with each of these objectives.

1. Ability of aerospace professionals to contribute in the City.

Participating "aerospace" professionals demonstrated a high capability of helping the city administrators to define and solve problems. Those involved included not only the Advisors, who were assigned full-time in their cities, but Company and other technical-support personnel working under advisors' guidance as well. This can be attributed partly to Program planning, which scheduled a learning phase for the Advisors and structured relationships so that the City Manager "sponsored" his Advisor with City personnel and the Advisor in turn introduced and managed his technical support to the City. It is also related to the skill and contacts of the Advisors, and the policy emphasis of the Program in the area of constructive, cooperative interpersonal approach. Finally it must be attributed in part to the openmindedness with which the city administrators received the Program, and the Companies supported it as a new approach to the interface problem.

2. Nature and quantity of technical support required.

The kinds and amounts of technical support required for such a program depend entirely on the approach and methods chosen. This Program was designed to establish and utilize a working, flexible channel of communication between cities and technology sources. Each Advisor constituted the resource to establish the channel. On the City side, the capability to define problems and then to implement solutions had to exist and develop, with the Advisor's help. On the industry-laboratory source side, the technical resources to meet demands coming up the channel had to be provided. The nature and amount of such resources tend to be limited and defined by the ability of the City (stimulated by the Advisor) to demand and the Advisor to transmit. In the initial phase implemented in this Program, much of the technology transmitted was associated with the support of problem definition and project management. Beyond this, technical support tended to support system study and acquisition rather than to provide operating systems directly. Such support is modest in quantity.

3. Exposure of city personnel to "systems approach".

This activity was successful and well-received by City Managers. System management was conveyed and taught to city personnel in three ways: (a) as a complete, overt system, in the case of Pasadena's adoption of Management By Objectives; (b) in simplified, subsystem form, usually in support of some explicit project, as in San Jose's system-study training and Anaheim's CATV selection and procurement support; (c) essentially by example and personal demonstration, as in Fresno's internal reporting system and the communications and presentations efforts in Anaheim and Pasadena.

4. Exposure of aerospace personnel to urban sociopolitical processes.

Understanding of this potential market for advanced systems and a variety of hardware and software items might possibly be gained without the direct immersion experienced in this Program, but not so readily or thoroughly. Provision for this understanding by the Advisors was made in the initial "familiarization" phase mentioned in Section V. A. 1 above. Evidence that it occurred during the Program is seen in the change of tone and discussion content in the Advisors' quarterly reports, and the records of the eight quarterly reviews, both described in Section V. C above. Advisors' comments on the progress and failure of certain efforts (e. g., the site-selection model described in Section III. B) are particularly revealing. The necessity of this exposure was an operating premise of the Program, and was not control-tested. However, its positive values may be seen in the City-oriented pilot projects completed during the Program, the Companies' conclusions regarding potential vs immediate marketing returns from participation (Section IV. A. 1 and Table 7), and the effect on some Advisors' career goals (Section IV. B).

5. Applicability of aerospace technology and expertise to cities.

The direct applicability of so-called aerospace technology as such to the problems of the cities proved rather limited; however aerospace expertise, in system analysis and project definition and management, was highly applicable. The City Managers' responses (Section IV. A. 2 and Table 8) appear to define "technology" more broadly than those of the Companies (Table 7), and assign it a greater role. Both suggest, as does a survey of Program activities and progress, that much more technology application will follow as an intended consequence of the utilization of Advisors' and Companies' expertise, for the process has barely begun.

6. Is this process beneficial to cities and the industry?

The evidence appears to agree that the cities have benefited and will benefit; for industry, it is not so certain. There is some indication from the Fresno transition that under some circumstances, such as abrupt interruption, benefits can be lost, though the rapid re-establishment and subsequent progress there show the viability of the process (and the skill of the participants). The Probeye instrument represents the only immediate market benefit to industry from this Program; some participating Companies anticipate possible future sales, and most indicated a generalized market-research benefit (see Section IV. A. 1). The general problem of market aggregation is discussed separately below. The willingness of Cities and Companies to continue the effort, modified toward direct financial support on the part of the former and away from the contributory participation of the latter, reflects both the imbalance of short-term benefit and the confidence in ultimate mutual gain.

B. INDEPENDENT CONCLUSIONS

A number of findings and determinations have emerged from the dynamics of Program activities and interactions which, though related to the scope of one or more of the formal objectives, are essentially independent of them. These conclusions relate particularly to the Advisor's role and relationships, to institutional (City/Company) roles and relationships, and to the transfer process itself.

1. Advisor characteristics and interactions.

The training and experience qualifications of the Advisors in this Program vary considerably (see Table 5) as do the tasks they were called upon to conduct and manage (Section III). The common general factor was the matching of technical management skills and experience with the need for applications in this area. A number of specialized abilities, predominantly the skills of communication but including such things as equipment fabrication, could be turned to the City's or the Program's benefit. Yet the variety of demands was such as to rule out any technical specialist for the role. The Advisor must be able--with specialist support--to confront the problems of any City Department. There was a slight tendency for those with hardware- or software-dominated experience or other special interest to gravitate toward or emphasize relevant problems or Departments, with, in most cases, an ability to grow beyond specialization or prior experience. The Advisor must be a professional capable of growth, and a manager.

The second conclusion regarding the Advisor's role and qualifications related to the fact that his position is one of trust in at least two directions. The Advisor must be able on occasion to speak for his City as well as his Company. Internal evidence shows that Advisors did in fact establish policy positions on behalf of both these institutions, with the concurrence of appropriate superiors. This validates the final selection procedures based on personal judgements by the appropriate Managers, as compared with total dependence on any stipulated criteria.

The third conclusion derives from the thesis that innovation is not intrinsically threatening. The combination of acknowledged professional status, evidence of trust by the City Manager, and a third factor turned a potential confrontation between old and new technique--revolution--into a mutually-achieved process leading from problem toward solution--evolution. This third factor, a soft-sell skill more easily recognized than defined, is more commonly associated with the political than the technical professions. Its presence in the Advisors in different stylistic forms is evidenced in the perception by city personnel that the new techniques were indeed reinforcing rather than threatening.

2. Institutional qualities and interactions.

Both the Companies and the Cities involved in this Program indicate that they have benefited from the broadening of experience provided as a consequence of participation; this was the subject of the third and fourth objectives (Table 2). But a further, more specific benefit to the Cities derives from access to a source of objective technical evaluation. City staffs tend to lack this capability, for in the short term, compared with the needs of service delivery and day-to-day problem-solving, facilities for large-perspective or specialized technical evaluation must appear almost a luxury. Each Department is concerned with its own needs and approaches. Similarly, however, an industry representative is limited by the parochial interests of his firm; any consultant has a combination of this and the limitation of his restricted familiarity with the City's problems. The Advisor in his Company relationship has the full technical access and ability of an industry man, but a greater detachment from pure Company interest; in his City role, he has the opportunity to become familiar with the background conditions and Department perspectives, but his external base and his internal location--on the City Manager's Staff--give him some detachment with respect to City affairs. Thus, a relatively balanced position between the two institutions--the supplier and the user of technology--though not without problems of conflicting interest, provides a prospective source of dispassionate technical judgment.

The development of this capability for specific procurements or specifications has been demonstrated in certain City pilot projects, in which the Advisor helped organize teams and

procedures for rigorous evaluations and selections. However, provision of an on-going technical evaluation capability (through the Advisor) is equally important.

While the internal-external nexus is required for the maintenance of this evaluation/judgment function, colocation of the local government and industry partners is not. This conclusion is argued in Section IV. B. 1 above. City/Company teams spaced as far apart as hundreds of miles functioned as effectively as those in which the Company was located close to the City.

An essential quality of the institutional relations in this Program is that of inter-City, inter-team reinforcement. The initial Program structure had established the four City/Company teams as essentially autonomous units, interacting principally in the course of Program review and evaluation. The Quarterly Review meetings principally involved the presentation by each City team of its past accomplishments and status to an audience of other City teams (including some from outside the Program), Program management, and the sponsoring agencies. While the meeting usually included topical roundtable discussion in which constructive interaction occurred, the review format led to the development of a somewhat competitive outlook, reinforced by the autonomy of the teams and the presentation by visitors of their technology-transfer plans and progress.

Ad hoc inter-City transfers of technical approaches and information, and joint meetings to initiate planning for a possible Program extension, suggested the positive value to individual City teams' efforts of increased interaction and cooperation. This joint planning effort, involving the City Managers, Advisors, Company representatives, and Principal Investigators as team members, led to the formation of a Policy Board of the City Managers, supported by other participants, and improved communications generally. This trend towards collectivizing the City teams both demonstrated the feasibility of such cooperation in planning and accomplishment, and indicated means (such as joint or common projects) of further enhancing the environment for technology application and transfer in the city.

3. Characteristics of the Transfer Process.

Outside this Program, there has been, and to some degree, still is a tendency to regard the fostering of urban technology application and transfer as an event, rather than a process, with an end as well as a beginning. Internalization of the process — not merely its products — is seen as the goal or end so far as city operations are concerned. "Market aggregation" — the rationalization of cities into a single economic institution as consumer; facing the institutions of technology, industry, and commerce as producer — is the corresponding large-scale goal. The experience of the Four Cities Program taken in concert with other observations and analysis suggests that these conceptions are rather naive and premature.

First, technology-innovation development and application are slow processes, measured against the duration of this program. Historians of technology argue that only in modern times has the cycle from the new, scientific or technical knowledge to broad, practical utilization been brought down to half a century or less. Urban technology application is only a stage in this process, but it is a difficult, complex and drawn-out stage. Review of the pilot projects undertaken in the Four Cities Program (Table 10) shows a trend toward management techniques and toward direct adoption of developed technology in the efforts completed. Adding other activities of the Program, a considerable number including most which require development or adaptation, remain in process. The program was intended to help shorten the technological lag, and it appears to have succeeded, but no amount of effort is going to abolish or radically reduce the time required to pass from development to broad and efficient use of new technology.

A mediating quality in this problem of time is the existence of a growth rate in the technology applications process itself. Where the pressure to learn and apply new techniques remains firm, and opportunities continue to be available, the pace and the level of effort clearly quicken with the passage of time. Within each city, but more importantly, among the Four Cities, new starts of innovative effort as well as progress and completion of older tasks, appear to intensify toward the end of the initial term, as the usefulness of the methods was demonstrated more and more broadly. This would not necessarily have occurred for a sporadic, isolated activity.

Internalization is the process whereby a new technique is adopted by its user. It is the transition from research laboratory to production line, from prototype to product. It is obviously a vitally important activity in the technological society. However, the internalization of the research function — or in the case of urban technology, forcing the city to research and develop its own technology — carries the concept farther than it can go. For the City is a user of technology, not generally an innovator. Its priority technical task is to deliver services and maintain itself, and it has neither the resources nor the time to go very far back up the chain of development towards technical research. Industry, decades ago, chose to cloister its research and development function in separate divisions, or independent firms, somewhat protected from the short-term demands of the production arm. Government agencies often fund the development and the production or operation of goods and techniques separately in a similar approach. Yet cities are neither rich enough nor specialized enough in their technical needs to be able to internalize in this fashion. Indeed, the need for the Four Cities Program, as well as its initial experience, shows that city management is constrained to rely on external sources, and even external mediation for new techniques and devices. Yet, at the same time, the cities participating in this Program have shown their willingness and ability to provide one footing of the necessary bridge.

The idea of market aggregation that many or even all cities could be welded together into a single unit of need and consumption of technology and its products, has been a popular one for discussion and hope. Although the Four Cities Program made no concerted attempt to form such a structure, it was possible to observe, through program activities, considerable evidence on this issue. It is not favorable, or even hopeful.

First, the initial need observed in the cities is for means and modes to discover, articulate and order the cities' needs. To the extent that needs were expressed, they were ordinarily specified particularly: the problems were seen as special problems, not readily susceptible to common solutions. Within the city administration, are many departments, each with an independent identity and an often parochial view of department needs, which may appear to an outsider to be common requirements.

The different requirements seen by the Four Cities for CATV service, for example — notwithstanding the information exchange from the successful Anaheim Project — would preclude simple transfer of the model ordinance. A second example is found in the varying approach to management systems. Pasadena successfully implemented the MBO comprehensive style. Anaheim adopted some program management techniques and Fresno some others. These all derived from aerospace industrial management control practices, but the implementations were selectively different. Transfer of MBO from Pasadena was initiated with cities outside the Program, and it is too soon to chart its development in different habitats. Differential reception of the Probeye Hardware System might be attributed partly to the lack of funds for broad testing in the other cities, but must also be laid partly to different perceptions of need, utility and cost. The vehicle replacement model and program initiated in Fresno was not directly adopted by other cities in the program though a modified competing version was used marginally in San Jose. The latter city's information system development were not picked up by other cities. These cases occur in spite of the fact that all the cities have, or considered, CATV service, management control needs and activities, fire suppression visibility problems, vehicles, and similar needs for information and data processing.

It should be noted of an area barely touched by program activities, an aggregated market could be asserted for electrical energy, but among the Four Cities, Pasadena generates its own, Anaheim's municipal utility purchases commercial power and distributes it, and Fresno and San Jose are serviced by private utility companies. There is some prospect for aggregating the purchase of data processing equipment, programs or service, but existing investment in, and establishment of, the systems in use, remains a barrier. In the case of vehicles and similar equipment, a combination of psychological investment — in local departmental autonomy — and environmental conditions, a natural difference between cities, militates against commonality.

General observations appear to confirm the view drawn from a few cases in the Four Cities. Local autonomy is a very powerful principle in the organization of our society, and in many fields of public service, each local jurisdiction defines its needs and specifies its wants quite independently of its neighbors. For example, a common fire hose coupling standard has long been prescribed in California law, yet many local districts maintain their "own" standards, as well.

Commodities which are purchased locally will conform to the specs of the local market. Those which are used in established systems — e.g., computer programs and accessory hardware — must be compatible with the previously specified systems. In certain special fields, some degree of standardization has been achieved as a condition of Federal mission agency support programs. The recent trend toward the revenue-sharing mode of aid to local government, is, of course, a trend away from federally imposed or encouraged standardization of technical requirements. Thus, it appears that the general standardization of technical requirements which is prerequisite to urban market aggregation, is dependent on the willing compromise by local specialists departments of a large measure of their independence. This social change is revolutionary in degree, and will likely occur over an evolutionary time scale. At the same time, evolution away from non-standard requirements imposed by established equipment systems and local markets will occur only slowly.

Naturally, where common standardization offers service improvement to the City at a favorable cost/benefit balance, it will be adopted, but the evidence shows that these factors are carefully sifted, and that decisions have to be made on other grounds than that of supporting the distant goal of the aggregation of a common urban market.

Yet in the short term of this initial phase of the Program, little if any progress was observed toward the standardization or rationalization of major equipment requirements. The problem of market aggregation remains one of slow development roward voluntary agreements by the users, aided by such initiatives toward attractive, useful, and cost-effective commodities as the producing sector can develop, and by in-depth inter-city understanding and coordination such as this Program appears to be creating.

C. RECOMMENDATIONS

The experience and evaluation of the Four Cities Program, leading to the conclusions discussed above, leads further, in some cases, to specific recommendations. The first is for serious and further consideration of a number of questions either not examined in this Program or emerging from it. Others have to do with immediate outcomes of the two years' experience and with more long-term matters.

1. Questions for further study.

Insofar as such matters can be specified, the degree of scientific and technical expertise necessary in the Advisor — given his access to a pool of specialists in the City, the Company, and other elements of his technical community — is certainly worth examination. Whether training in psychology, economics, or business administration — exemplified by certain of the Advisors in this Program — is important in establishing and maintaining the relationships with City personnel which contribute to the transfer of new knowledge, or whether the skills required are innate, or built from business or management experience, should be better understood. Even more important to the Advisor's role is the question of long-term dynamics: should the Advisor have a long-term assignment, or should he be "rotated" after a year or two? So long as it is an uncommon role, he may be relatively isolated from professional peers, and within his Company, and lack the reinforcements and

opportunities to share experience which are regarded as essential to career maintenance and growth. Further, the demands of the City — technologist position in the current pioneering position may exhaust the Advisor in a relatively short period. This whole field of longer-term effects could not be studied within the limited scope of the Program.

The Cities which participated in this Program were similar in some respects, particularly in the form of government. Within the framework, a number of operational questions remain, such as the possibilities of closer contact of the Program with the elected officials — Mayor and Council — on the one hand, and of concentrated effort with particular Departments — partly but not fully experimented with in some cases, but generally avoided in this Program — on the other. Further, the differences in interfacing with Mayoral, Commission, or Town Hall forms of government remain to be studied, as do the possibilities of establishing an Advisor Team for larger cities, a shared Advisor between small towns, and a contiguous regional program. The latter possibility would appear most susceptible to development from the Four Cities activity, and its possibilities have been studied for planning purposes, and entered experimentally as a consequence of pilot-project activity in various cities such as the MBO and CATV activities in cities neighboring Pasadena and Anaheim and Fresno's regional-scope waste management study.

Finally, considering the technology-resource institution, a better understanding of the comparative characteristics of various types of institutions is desirable. Universities, city agencies, commercial companies, and government laboratories have been involved in the transfer process, within and outside this Program. Ways of meshing together and selecting from among their capabilities might, for example, bring about the more direct development of distinct and collaborative roles for each institution, including an adequate market potential for industry. Up to now, as seen in Program and related experience, such investigation has been exploratory at best.

2. Allowance for growth factors.

The spectrum of alternative modes for achieving widespread application of technology to urban management and service-delivery operations runs all the way from beginning with a single city and growing one-at-a-time to starting simultaneously in all cities. The experience of this Program shows both the difficulties of managing and coordinating technology transfer and application efforts in even a small number of cities simultaneously and the significant on-going benefits to each city of coordination and communication with the others. It also shows the existence of a learning process at all participating levels, and a definite increase in coordinative capabilities, which should be reflected in an increase with time of the optimum number of participating cities.

On the basis of these observations, a phased expansion of the application of the process demonstrated in this program is recommended, in order to best utilize the learning capacity of technical, city, and program-management participants.

3. Regional growth from this Program.

Growth of rationalized technology transfer to local government from the Four-Cities-Program scale of operations could proceed along two or more lines. One way is to undertake similar activities in more cities. The needs of increasing general understandings (Section V. C. 1, immediately preceding) would perhaps be met by selecting dissimilar cities to those in the Program, varying conditions according to a set program, etc. However the needs for rational growth of the process of making high technology available to cities, together with benefits observed in the Four Cities from intercity reinforcement, would suggest that the most constructive growth line should be a regional one, in which neighboring cities are added to those already active in this Program. That neighboring cities are amenable to constructive collaboration is demonstrated in the recent effort of Anaheim with three other Orange County cities to place a legislative advocate in Washington, D.C.

A second mode of growth for the urban-technological connection is vertically, from City to County to State. This has been tentatively explored in Fresno between City and County, and the Director of the California State Office of Science and Technology has participated throughout the Four Cities Program on an information-exchange basis. Activities at the County and regional Council of Governments levels open up a range of technical problems in which a City's scope is limited, such as air pollution and waste management. Further, such a direction of growth can lead easily to the involvement of additional Cities within the County or regional Council.

Thus it is a recommendation, based on the experience of the Four Cities Program and considerable planning analysis by its participants, that expansion be in the vertical/regional direction.

4. Maintaining and strengthening the Advisor's role.

It is a common observation among Advisors and City Managers (Table 8) that the Advisor's independence of the City organization is a great asset to him, to the City, and to the transfer program. This is also a conclusion of this Program (Section V. B. 1). The way premised and demonstrated in the Program to support his independence was for him to have and retain a position with an industrial technical company, which served as primary technological resource, supported by the Laboratory which managed the Program and by other institutions as available. Some external relationship such as this is essential; the Company connection demonstrated in this Program was highly successful. It is recommended that this mode be continued.

At the same time it was observed that inter-Advisor contact was a powerful reinforcement to the efforts in the individual Cities. The Advisors were strengthened by their institutionalization as a professional group, however small. It is therefore a further recommendation that coordination of the Company-Advisor-City teams into a league linking through the Advisors, be pursued actively.

5. Strengthening the City activities.

The Cities which participated in this Program, serving as laboratories for the experimental development and partners in the management and conduct of technology introduction, invested considerable effort, interest, and other resources in the activity during the two-year term. In 1973, through the formation of the Policy Board, they formalized and gathered together the City Managers' responsibility for directing the application of Program efforts in the Cities. To help support extension of the Program beyond the first two years, each City committed limited funds directly. Since certain benefits of the Program accrue directly to the participating Cities, it is proper that they should share the cost. Other benefits, however, serve the generality of Cities. Yet as long as the participating Cities, four or forty, are the laboratories where new techniques and applications are tried and demonstrated, they must have authority over operations. The balance between local and general support and responsibility, depending on the balance between direct local and indirect general gain, remains to be worked out, and will always remain fluid. Yet the principle of local responsibility will always be important, and its application is firmly recommended.

A further recommendation regarding the Cities has to do with a local supporting institution. The dominance of City concerns by short-term needs (Section IV. B. 1 and elsewhere above) has contributed to the requirement for independence for the Advisor, who is interested largely in longer-term matters. The Advisors have tended to associate to some degree with City Systems or Research Departments, whose concern and capabilities tend toward the longer term, however limited. It is recommended that the Cities consider establishing, re-establishing, or strengthening the appropriate systems-analysis-oriented offices, wherever they may best fit the organization, to broaden the base in City government for the definition of problems and the initiation of projects. Such a function must have both a quick-response element and a longer-range one, to meet immediate needs without sacrificing the essential research application capability.

The foregoing recommendation is equally applicable to cities outside the Program. Experience from the inception of the Four Cities Program strongly indicates that a useful precondition in each City was in fact the existence of indigenous efforts, which served as a halfway point or opening. Any such opening, including technology orientation in a volunteer Community Council or the Chamber of Commerce, or a volunteer Science and Technology Committee, would provide similar advantages, and its existence might even become a criterion in the selection of cities for future programs.

6. Role of a regional coordinating and technical center.

During the two-year term of the Program, coordination and inter-communication between City teams were provided by the Jet Propulsion Laboratory as project management agency, and technical support was also provided when requested. The primary technical resource was intended to be the Company member of each team, supporting the resources existing within each City, and augmented ad hoc from local academic institutions. However the existence of a single supplementary technology source, familiar to the City teams and involved in all aspects of the Program as well as a broad range of technologies, was found to be a definite asset. Identification of such an institution as a permanent component of the urban-technology process appears to be the logical next step.

The establishment of regional technology centers to interface between government-sponsored research resources and commercial and urban users of technology was suggested and outlined by W.H. Pickering, Director of the Laboratory, in invited testimony before Senator John Tunney's Science, Technology, and Commerce Subcommittee of the Senate Commerce Committee on October 4, 1973. Such a suggestion arises from the Four Cities Program experience, and is recommended as a result of the Program.

7. Funding support of urban technology introduction

Previous conclusions and recommendations have touched on the problem of local responsibility for technology transfer and innovation programs, and on the need for the participating local government to share in the cost. It has also been pointed out that some benefits from the Program accrue to all cities, not just or necessarily to those in which they are tried or developed. The City Managers agree that their Cities would be willing to support efforts which result in cost savings or other tangible benefits, but that more generalized efforts might better be otherwise funded. It is certainly doubtful that the Cities could or should bear the total cost at any stage.

The experience of the Agricultural Extension Service provides a key to this question: its support comes jointly from Federal, State, and local sources. An urban technology program should similarly look to multi-level government support, together with possible non-governmental sources. The mix of such supporting levels remains to be determined, but it can be recommended that mixed support be planned for, on a flexible basis, rather than an attempt to require purely local or (after the initial phase) federal support according to a fixed principle.

The conclusions and recommendations of this report are summarized in Table 11.

Table 11. Summary of conclusions and recommendations

General Conclusions:

1. The technology-application mode demonstrated in this Program — City/Company teams with Company-based Change Agents and inter-team coordination by a Government Laboratory — is viable and successful.
2. Interest and motivation of the City Manager and his staff, Company management, and Advisor or Change Agent are crucial to the process.

Considering Project Objectives:

1. Aerospace professionals are capable and effective in contributing to definition and solution of city problems.
2. Technical support required (on a demand basis, through Advisor) included consultation, training, and technical studies, performed by Companies, Government Laboratory, and composite teams.
3. The "systems approach" was accepted, learned, and utilized by City personnel in many cases.
4. Participating aerospace personnel and Companies gained new and useful understanding of urban processes and conditions, but did not develop significant immediate marketing prospects.
5. Aerospace hardware technology found little application, but software techniques and project management and technical expertise were broadly and successfully applied in the Cities.
6. The process was immediately beneficial to the Cities; Company benefits, beyond generalized market research, were limited.

Independent Conclusions:

1. Advisor characteristics and interactions:
   a. A wide variety of skills and experience could be utilized by the cities, but the Advisor role is that of a generalist and manager.
   b. The Advisor earned a position of trust in the city like that previously earned in the company.
   c. The Advisor was generally able to reduce tension and barriers raised against the perceived "threat" of innovation and win acceptance for new techniques.
2. Institutional qualities and interactions:
   a. The Advisor's detached/integral role in the city made possible an objective technical evaluation function as needed.
   b. Location of the team-partner Company and technical resource within the City is helpful but not necessary in this kind of operation.
   c. Inter-city, inter-team re-inforcement and cooperation proved very important in sustaining motivation and the pace of technical progress. Direct collaboration in pilot projects and planning would be useful practice.
3. The technology transfer process:
   a. The time lag in the application of technology may be logically reduced in specific cases, but it remains generally a long period.
   b. The ability, interest, and activity to foster technology application and transfer to cities show a cumulatively increasing growth rate, slow at first, but increasing with time.
   c. Internalization of specific techniques and devices into City operations, case by case, is generally successful; however, internalizing the technical research and development or technology transfer function is far more difficult if possible at all.
   d. Market aggregation of urban technology generally is a very distant goal, although with a few commodities and services, it is feasible in the near term through inter-governmental structures which encourage standardization.

Recommendations

1. Questions for further study: Study is urged in the following areas:
   a. Details of the technical skill profile required in the Advisor; tenure of an individual in the Advisor role.
   b. Differences in approach necessary for dealing with different forms of city government, for operation of multi-Advisor teams, or shared Advisor to cluster of smaller cities.
   c. Capabilities and roles of different and mixed institutions as technical resources for city application.
2. Allowance for growth factors: A phased expansion from the multi-city, regionally coordinated type of program demonstrated here is recommended.
3. Regional growth from this program: The direction of growth should be towards regional levels of government and towards cities neighboring these already participating.
4. Maintaining and strengthening the advisor's role: It is recommended that the Advisor's role as a senior professional of high-technology industry, assigned to the City Manager and working in the City but professionally independent of it, be maintained. It is further recommended that inter-Advisor linkage into a professional peer group be established and maintained.
5. Strengthening the city activities: It is recommended that the Cities retain responsibility for their local parts of the Program, and, through a City Managers' Policy Board as established in this Program, for collective management of the effort. It is further recommended that the Cities establish and maintain internal systems-analysis functions with both long-range and quick-response functions. Cities which are not part of an organized technology-transfer program can promote their participation in such programs by seeking to share specific products developed by cities already in programs; by identifying a city employee to be responsible for technology coordination; and by seeking industrial and research-community support for a volunteer Science and Technology Advisory Committee for the city.
6. Regional coordinating and technical center: The establishment or assignment of regional technology centers to interface between government-sponsored research sources and commercial and urban users of technology is recommended.
7. Funding support: It is recommended that the cost of technology application and transfer be borne jointly, in a flexible balance to be determined in practice, by federal, state, and local governments, with help if possible from non-government sources.

REFERENCES

1. Committee on Intergovernmental Science Relations, Public Technology: a Tool for Solving National Problems. Executive Office of the President (GPO, Washington, D.C.), May 1972.

2. Proposal for a Pilot Demonstration Project of Technology Application from the Aerospace Industry to City Management, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif., February 22, 1971 (unpublished).

3. Interagency Agreement No. NSF-CA58, between National Science Foundation and National Aeronautics and Space Administration, Office of Advanced Research and Technology, Technology Applications Office, Washington, D. C. June 1971 (unpublished).

4. G. F. Ervin and L. S. Blomeyer, First Annual Report: Four Cities Program, Jet Propulsion Laboratory, California Institute of Technology; November 15, 1972; available from Department of Commerce National Technical Information Service (NTIS) as PC-213 836.

5. J. H. Wilson and H. L. Macomber, High Technology Faces Urban Problems: Four Cities, an Interim Report, Document 1200-100, Jet Propulsion Laboratory, California Institute of Technology, September 14, 1973, available from NTIS.

6. R. M. Davis, "CATV: The Anaheim Experience," presented at International City Management Association Conference, Boston, Mass., September 24, 1973.

7. J. W. Forrester, Urban Dynamics, MIT Press, Cambridge, Mass., 1969.

8. R. Blake and J. Mouton, The Management Grid: Key Orientations for Achieving Power Through People, Gulf Publishing Co., Houston, Tex., 1964, and Corporate Expansion Through Grid Organizational Development, Gulf, 1968.

9. Isabel Briggs Myers, The Myers-Briggs Indicator; Manual 1962, Educational Testing Service, Princeton, N. J., 1962.

10. Quarterly Review Minutes, compiled by JPL project staff, Jet Propulsion Laboratory, California Institute of Technology, various dates (see Table 7) (unpublished).

11. M. R. Licciardello and B. Reiss, "The Technology Transfer Process – Where's the Bridge?" presented at Third Urban Technology Conference and Technical Display, Boston, Mass., September 25, 1973, AIAA Paper No. 73-997 (also available from NTIS).

12. L. S. Blomeyer, A Plan for Technology Application from High Technology Industry to City Management (A Program for Cities), Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif., November 30, 1972 (unpublished).

APPENDIX A: CHRONOLOGY OF PROGRAM AND RELATED EVENTS

October 1970	First Urban Technology Conference, Cape Canaveral, Florida: ICMA Technology Applications Program Solidified; NSF Intergovernmental Science and JPL representatives meet.
November 1970	Initial planning meetings, NSF/JPL
February 22, 1971	JPL Proposal for "Pilot Demonstration Project" (Ref. 2)
June 1, 1971	Requests for Proposal to industrial participant selectees
June 24-25	Initial participants' meeting (at JPL)
July 26	Fresno Advisor, J. Wakeman, TRW Systems, arrives
August 1	Anaheim Advisor, J. Glascock, NARISCO, arrives
September 2	JPL Contract 953254, TRW Systems, executed.
September 22	JPL Contract 953251, Space General (Aerojet), and Contract 953252, Lockheed Missiles and Space Company, executed
in September	San Jose Advisor, J. Weiss, LMSC, arrives
October 4	Pasadena Advisor, Forrest Warren, Space General, arrives. NARISCO and JPL agree to terminate negotiations, NARISCO pledges to maintain Advisor in Anaheim at company expense through 1971. Northrop Corp. invited to join Program as Anaheim Partner.

November 12	First Quarterly Review of Program (at JPL)
January 13, 1972	JPL Contract 953367, Northrop Corp., executed; new Anaheim Advisor, W. Armstrong, Northrop, arrives
In January/February	Meetings at JPL, Fresno, Anaheim between City personnel, Advisors, JPL personnel on pilot projects
February 9	First LMSC technical seminar in San Jose
February 17-18	Second Quarterly Review of Program (at Fresno)
February 18	First presentation of MBO to Pasadena management by Aerojet personnel
May 18-19	Third Quarterly Review of Program (at Pasadena)
In May/June	JPL/TRW discussions regarding departure of Advisor and continuation of activity in Fresno
June 7	Testing of Probeye instrument by Anaheim proposed
June 9	D. F. Spencer, Principal Investigator, reassigned to support NSF/Washington; L. S. Blomeyer appointed Principal Investigator by JPL
June 13	Anaheim CATV ordinance approved, procurement begun
July 24-26	Second Urban Technology Conference
August 10	Proposal received from LJRBA/SAI to take up Fresno activity
September 7	JPL Contract 953553, LJRBA/SAI, executed; new Fresno Advisor, M. Licciardello arrives Sept. 11
September 14-15	Fourth Quarterly Review of Program (at San Jose)
October 21	President's Science Advisor, Dr. Edward E. David Jr., reviews Program with Principal Investigator and Advisors; Dr. David requests national plan (submitted November 30).
November 13-14	Interagency Committee sponsored by Office of Science and Technology reviews Program at JPL, Pasadena, and Anaheim.
December 13	Presentation of Program status to NASA officials, through R. D. Ginter, NASA/TA.
December 14-15	Fifth Quarterly Review of Program (at Anaheim)
February 28, 1973	Presentation of Program status to federal officials (in Washington) through M. F. Hersman, NSF/OISRU
March 2	Space General merged into Aerojet Liquid Rocket Company, Sacramento
March 15	Sixth Quarterly Review of Program (at Fresno)
In March	John D. Phillips, Pasadena City Manager, retires; succeeded ad interim by Donald Pollard; Donald McIntyre selected to succeed Phillips.
May 7	U. S. General Accounting Office requests Program briefing (held May 24-25), subsequently conducts general study of Program.
In June	Donald McIntyre assumes duties in Pasadena
June 29	Seventh Quarterly Review of Program (at Tacoma, Wash.)
July 20	Solid Waste Management Conference at Fresno
August 1	L. S. Blomeyer, Principal Investigator, reassigned by JPL; succeeded by H. L. Macomber
September 15	Eighth Quarterly Review of Program (at JPL)
September 19	Proposal to extend Four Cities Program submitted to NSF/OISRU
September 24-26	Third Urban Technology Conference, Boston, Mass.

APPENDIX B

EVALUATIVE COMMENTS BY JOHN D. PHILLIPS

Mr. Phillips, who retired as Pasadena City Manager in March 1973, prepared the following remarks in response to the "city policy questions" which were submitted to him in November. The extended analysis he provided, from a rather special perspective, is reprinted below.

My answers will be somewhat dated as far as the City of Pasadena is concerned as I have been away from it for eight or nine months. So the replies to the questions reflect my opinions and not those of the City.

1. Does a city need a "Science Advisor?" If so, what backup services are required from whom?

The word "need" depending upon its interpretation may be a little strong. There is a need if certain benefits are to be obtained. If a city desires to forego the benefits, there is no need. So, stated the other way, there are benefits, which can be lasting, by a city having a "science advisor." The benefits arise from:

a. The knowledge gained by city people that there is a large reservoir of technology which can be applied to city problems;

b. Through the Advisor having a "pipeline" to this technology;

c. The Advisor being on the city staff is a person who is able to review city problems and determine which are susceptible to such technology for use in solving such problems;

d. The education of city people in the methods of problem solving used by the aerospace industry, and in the management methods and processes used by the industry;

e. A development of knowledge, skills, and methods of approach by the city people.

Backup services are required to do the following:

a. An advisor does not know all of the technology or where to find it. This is beyond the scope of one man. The backup can broaden the range for the city.

b. Specialized services will be required from time to time, depending on the projects involved. The backup service can supply the specialized need.

c. Provide assistance of various kinds on projects and provide a resource for changes in and additions to the technology. This is an expanding field and one advisor isolated on a city staff needs this kind of assistance.

The backup services can come from a number of sources. The source, however, should be one to whom the advisor is known and with whom he is familiar and based upon a committment to provide such service. Generally if the advisor is from a particular firm, backup from that firm would be advisable because of the ease of entry and obtaining information and assistance by the advisor. He is dealing with his own people.

2. Is this approach to promoting the use of technology a realistic one?

The answer is yes. The four cities provide the laboratories wherein the technology is used and from which the benefits of its use may be documented. However, use in these four cities is not enough. The key words in the question are "promoting the use." This demands the documentation and the dissemination of the uses, results, and benefits to the cities of the nation. Without this, four cities have been benefitted - no more.

3. What technological solutions for increasing local government services and productivity have been brought to the attention of your city from its participation in the Four Cities Program?

The answer to this should come from the present city staff of Pasadena. However, in my opinion, the greatest benefit to Pasadena came from education of staff and departmental personnel in new approaches to problem solving, including defining the problem and reducing it to its components, and in evaluation of proposed solutions. In city operations solution of a problem involves, in many cases, working with citizens and obtaining public acceptance (the "best" solution may not be the feasible one from this point of view). Thus, evaluation of solutions and developing backups for solutions is of extreme importance in arriving at a solution that is acceptable and can be adopted.

The second major gain to Pasadena is the adoption of a new management process — management by objectives. This meets a great need in cities — accomplishing projects after they have been approved in a consistent, determined manner.

4. Was anything, either software or hardware, delivered to: the City; to other cities; to industries; to sponsors?

The delivery was to the city of Pasadena. Involved were: criteria and evaluation systems for solving problems of location of public facilities — a firehouse and a heliport; the MBO system; and a device to be used on the helicopters to record when the helicopters left one city and entered another and which cities were involved. This created a log for the helicopters. The balance was the educational process.

5. Was technology brought into the city accepted and used? Did it bring about change?

It was not only accepted and used but eagerly sought after by the departments. After an initial period of "getting acquainted" the departments

sought out the advisor requesting assistance on many projects. Thus the initiative came from the departments as well as from the advisor.

Changes were clearly evident in the methods of approaching problems, evaluating solutions, and presenting them to the Council and the public. MBO, at the time I left, was just being adopted so changes were not more than indications of things to come.

6. What kind of transfer was realized between the cities, industries, and sponsors?

In each of the four cities transfers were accomplished by the advisor with the aid of the backup industry. In some cases I had the feeling that a real transfer, in the sense of increasing city capabilities, was not taking place but the advisor was merely assisting in an installation. The city would have a better installation but would not have increased its capabilities and would not have technological solutions that it could not have obtained in other ways.

At the time I left I could see no evidence of transfer between the four cities, although through the meetings each was fully informed as to what the others were doing. The one exception was the device developed in or for Anaheim to locate fires in walls, etc. This seemed to evoke interest in all cities and the other three appeared to be waiting for its full development and placing on the market.

7. Is the existence of a science and technology program useful in improving local governments' use of revenue sharing funds?

I cannot answer this question as the revenue sharing became a fact after my last budget had been approved. We adopted a policy of using a portion for one-time capital and maintenance items (so as not to commit future funds), and saving the balance for the next year's budget development. Much has been said about the general revenue sharing but it is exaggerated. For Pasadena, for 1973-74, the budget indicates a "general city" budget of $39,360,000 of which $1,073,000 — or 2.7 percent — is expected to be general revenue sharing. The total budget is $69,536,000 of which the revenue sharing is 1.54 percent. You don't have to be very scientific when inflation increases your costs more than this in one year.

If special revenue sharing materializes, it will be another story. Criteria and evaluation processes will be very important and the knowledge Pasadena has acquired from the Four Cities Program can be put to good use.

8. Can cities benefit from new R&D relationships with Industry? Universities? Federal laboratories? Are the efforts cost effective? Will cities pay the bill or if services are required, who should?

Cities can benefit from relationships with any agency or institution which can provide technological solutions to city problems. The benefit will be far greater if the city has a science advisor on its staff. He will know where to look and what to look for to solve problems and will aid in determining whether solutions reached in other cities are applicable to his city.

Cost effectiveness raises a different problem. In some instances cost effectiveness can be documented; in others, such as processes for problem solution, it may not. In cities solutions must be acceptable to the public and the acceptable solution may not be the most cost effective solution. Hence the problem solving process may be made more valid, offer more alternatives, indicate cost effectiveness, and provide a means for better understanding the effects of differing solutions, but may not lead to the most cost effective solution measured in dollars or other items of dollar value. However, if cost is measured in terms of an appropriate acceptable solution, it can be considered cost effective.

The reported action of all four cities in accepting a portion of the costs of the program indicates its value to them. It validates the assumption that if cities are aware of the benefits of such a program, they will support it.

A valid question can be raised on full support. If the programs in the four cities result in technological solutions which are transferable and the information about which is disseminated to all cities, should these individual cities bear the entire costs of providing benefits to all cities?

My feeling is that they should not. There are benefits to them and benefits to all cities. Hence some support for such cities should be provided. How to develop a valid and acceptable formula or criteria, I am not prepared to determine. I leave that to you.